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Research Article

The Changing Trends in the Prevalence of Type 2 Diabetes Mellitus Among the Persons with Type 2 Diabetes Mellitus

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ABSTRACT:

Background- Diabetes mellitus is global health problem & prevalence is increasing worldwide. In recent years, age of onset of Type 2 Diabetes Mellitus (T2DM) is decreased which has been seen in several studies. Thus, prevalence of T2DM among young population has increased. In India, there are less studies regarding age of onset of T2DM.

In our study we studied age of onset of T2DM and its correlation with present age of persons with T2DM.

Materials & Methods- All the persons with T2DM who visited our hospital satisfying inclusion criteria were enrolled after taking proper consent. Total 1000 individuals where included, age of onset of T2DM was noted and correlated with various epidemiological variables.

Results- Among 1000 cases, 43.8% were males, while 56.2% females with mean age of onset of T2DM 47.61±9.54 years. In our study, 244 cases (24.4%) have self-reported age of onset ≤40 years of T2DM of which 172 cases (70.5%) are ≤40 years at present. The total cases of self-reported age of onset ≤40 years of T2DM were 244 (24.4%) ; among them, 68 cases (27.86%) had Hypertension, 198 cases (81.14%) had Body mass index >23 kg/m^2 , 207 cases (84.83%) had family history of T2DM and 169 cases (69.26%) were engaged in physical activity <150 min/week.

Conclusions- The prevalence of T2DM has increased drastically in recent past. The various risk factors play a significant role throughout the spectrum of all ages of onset of T2DM and must be addressed to delay the onset of T2DM.

KEY WORDS: prevalence, young diabetes, T2DM, age of onset of T2DM.

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INTRODUCTION:

Diabetes mellitus (DM) is a chronic metabolic disease, characterized by hyperglycemia, which can be attributed to either impaired secretion of insulin or defective insulin action or both. DM is a major health problem in the world leading to considerable morbidity and mortality. Prevalence of diabetes is expected to rise exponentially, currently 77 million people in India and 463 million people are living with diabetes across the world, and this number is expected to rise to 101 million in India and 578 million globally by 2030 which could mostly be attributed to unhealthy lifestyle, increasing life expectancy, illiteracy, lack of awareness and low socioeconomic status.[1,2,3]

This rise in prevalence of DM may be because of increase in life expectancy of people living with diabetes and its early age of onset. In recent years few studies have suggested that the age of onset of Type 2 Diabetes Mellitus (T2DM) has declined and is detected

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in early ages, which was initially considered classically the disease of old age.[4] DM is associated with certain risk factors, which can be non-modifiable or modifiable. Non modifiable risk factors include advancing age and family history, whereas modifiable risk factors include obesity, hypertension, dyslipidemia, decreased physical activity, unhealthy diet etc. [5,6] Early-onset T2DM is usually considered as occurring below the age of 40 years. This can be further separated into child and adolescent (less than18 years) and young adult (18 to 25 years).Early-onset T2DM has been reported in countries with different ethnic and cultural backgrounds.[4]Early onset of diabetes is associated with prolonged course of illness, which could lead to higher rate and early onset of diabetes related complications. As DM not only affects the health of an individual, it also has significant impact on functional capacities as well as quality of life of an affected individual. It is one of the major contributors of premature mortality as more than one third of diabetes related deaths have been documented in individuals below 60 years of age. [7,8] With an increasing incidence worldwide, DM will be a leading cause of morbidity and mortality for the foreseeable future. Although T2DM is a disease related to aging, the prevalence of early-onset has increased globally. [7-10]

In India, there are not many studies regarding age of onset of T2DM. We aimed to study the age of onset of T2DM in persons with T2DM and its correlation with their present age.

MATERIALS & METHODS:

This was an observational cross-sectional study conducted at our Medicine and Endocrine Outpatient Department (OPD). The study was approved by Institutional ethical committee. A total of 1000 individuals known to have T2DM were recruited consecutively for the study. An informed consent was obtained from the participants. Inclusion criteria included (1) all adult with previously diagnosed withT2DM on treatment, and (2) willing to participate in the study. Exclusion criteria included (1) persons with gestational DM, (2) secondary DM, (3) Type 1 DM, (4) Latent Autoimmune Diabetes in Adults (5) Maturity-onset diabetes of the Young and (6) not willing to give consent to participate in the study.

Detailed clinical examination and clinical records were noted of individuals. Statistical analysis (by using chi-square test) was performed on all eligible subjects enrolled in the study. The prevalence of all changes has been summarized as counts and percentages.

RESULTS:

1000 individuals with T2DM with mean age of 51.12±10.92 years were included inthe study. The male-to-female ratio was 0.78:1.Among the 1000 cases, 244 cases (24.4%) have self-reported age of onset ≤40 years of T2DM of which 172 cases (70.5%) were ≤40 years at present, this suggests that the prevalence of T2DM has increased among young in recent past.

Details of self-reported age of onset of T2DM is described in table 2. The prevalence of T2DM increased from 0.4% in 1991-1995 to 57.4% after 2020, also prevalence of T2DM in cases with self-reported age of onset ≤40 years was none in 1991-1995 which increased to 25.43 % after 2020, as depicted in table 1. In our 244cases reported, age of onset of T2DM ≤40 years, 68 cases (27.86%) had hypertension 198 cases (81.14%) had body mass index>23 kg/m2, 207 cases (84.83%) had family history of T2DM and 169 cases (69.26%) were engaged in physical activity <150 min/week.

DISCUSSION:

In India, the cases of diabetes are increasing significantly and it is one of the major public health problems. Though previously, T2DM was considered as disease of elderly, early onset diabetes i.e. occurrence of diabetes before 40 years of age is also not uncommon.[6] Literature suggests that Indians present with T2DM at younger age as compared to Western population. Indians also differ in body composition, though the BMI may be same, but they have higher fat content and low lean body proportions. [11] Advancing age is a non-modifiable risk factor for diabetes and age at presentation depends upon various factors such as health seeking behaviour of patients, presence of symptoms etc. In our study population, mean age of participants was 51.12±10.92 years and 653 (65.3%) cases belonged to 41 to 60 years of age whereas, 172 (17.2%) cases belonged to ≤40 years of age. The mean age of patients in ICMR INDIAB-17 (2023) was 43.0 years, indicating early age of onset of diabetes in India. [12]

In our study, majority of cases enrolled with diabetes were females (56.2%, n=562), as compared to males (43.8%, n=438). Our study findings were concordant with the findings of ICMR INDIAB-17 (2023), in which the prevalence of diabetes was found to be 53.5% in females and 46.5% in males in India.[12] In our study, the mean age of onset of diabetes among males was found to be slightly higher (51.76±11.54 years) as compared to females (50.62±10.39 years). The findings of present study were concordant with the

Table 1: Prevalence of T2DM over last few years in patients having self-reported age of onset ≤40 years with T2DM

Year of diagnosis	No. of patients (n = 1000)		Age at onset		Patients having self-reported age of onset = 40 years with T2DM	
		%	Mean	SD		%
1991 -1995	4	0.4	45.00	11.343	0	0
1996 -2000	14	1.4	46.79	8.496	4	28.57
2001 -2005	26	2.6	45.46	10.670	10	38.46
2006 -2010	57	5.7	48.37	8.719	15	26.31
2011 -2015	73	7.3	50.56	10.327	10	13.69
2016 -2020	252	25.2	48.09	10.105	60	23.80
>2020	574	57.4	47.08	9.170	145	25.43

Table 2: Association of self-reported age of onset of T2DM with age

Age (years)	Self-reported age of onset of T2DM (years)					
	=40 (n=244)		41 -60 (n=669)		>60 (n=87)	
	n	%	n	%	n	%
<40	172	70.5	0	0.0	0	0.0
41 -60	69	28.3	584	87.3	0	0.0
>60	3	1.2	85	12.7	87	100.0
Mean±SD	39.05±7.64		53.19±7.21		69.02±6.86	
$?^2$	1074 .56					
p -value	0.001					

findings of ICMR INDIAB-17 (2023),the mean age of male cases was significantly higher as compared to the female cases (44.0±0.11 years vs. 42.1±0.09 years; p<0.05).[12]Our study findings were concordant with findings ofAmed S et al (2018) documented increase in incidence of early onset diabetes among females during over the decade from 4.4 cases per 100000 per year in 2002 to 2003 to 7.21 cases per 100000 per year in 2012-13, but the change in incidence among males could not be observed.[13]

In our study, mean self-reported age at diagnosis of diabetes was 47.61±9.54 years and age of onset of diabetes was ≤40 years in about 24.4% (n= 244) cases of them. Among 244 self-reported cases, in 24.4%, age of onset was ≤40 years of T2DM of which 172 cases (70.5%) are of age ≤40 years at present, this suggests that the prevalence of T2DM increased in recent past amongst younger population. We found that, mean self-reported age of onset in patients belonging to less than 40 years of age was 34.44±5.07 years, whereas mean age at onset was 48.07±5.94 years and 68.81±8.16 years in patients belonging to 41 to 60 and elderly age group respectively. Our study findings were concordant with findings of Siddiqui MK et al (2022), the mean age of patients diagnosed before 40 years of age was 34.1 year whereas the mean age of patients diagnosed after 40 years of age was 52.6 years.[14]

We enquired about year of onset of diabetes to assess the change in age at diagnosis over past few decades. In our study, prevalence of T2DM increased from 0.4% (n=4) in 1991-1995 to 57.4% (n=574) in after 2020, also prevalence of T2DM in cases with self-reported age of onset <40 years was none in 1991-1995, which increased to 25.43 % (n=146) after 2020. According to a study conducted by Patel B et al (2020), the mean age of onset of diabetes was 48.53 years during 1991 to 1995, which decreased to 42.70, 41.98, 39.5 and 35.79 years in 1996-2000, 2001-2005, 2006-2010 and 2011-2015 respectively, with slight increase to 36.14 in 2016-2018.[15] There are various epidemiological variables which lead to early age of onset of T2DM.We found that, out of the total cases of self-reported age of onset ≤40 years of T2DM, 68 cases

I(27.86%) had HTN, 198 cases (81.14%) had BMI >23 kg/m^2, 207 cases (84.83%) had family history of T2DM and 169 cases (69.26%) engaged in physical activity <150 min/week. In the study of ICMR INDIAB-17 (2023), about 28.6% were found to be obeseand about 35.5% were found to have hypertension in India.[12]In the study of Panikar VK et al (2008), they reported a significant decline in mean age at onset of diabetes from first generation to second generation i.e. from 55.95 years to 38.4 years.[16]Our study finding were consistent with the study of Hao Z et al (2022), the mean age at onset of DM was significantly younger in patients with positive family history in both parents (47.5±11.0), and in father (47.9±11.1) and mother (51.1 ± 10.5 years) as compared to patients with no family history of diabetes (54.1 ± 10.5 years).[17]

CONCLUSION:

The prevalence of T2DM has increased drastically in recent past. The age of onset of T2DM is declining over decades. There were no cases of T2DM with age of onset ≤40 years in year 1991 to 1995, which increased to 25.43 % cases 2020 onwards. Thus, the prevalence of T2DM has been increasing in the young population. The risk factors may be family history, compromised physical activity, increased body mass index and co-morbidities like hypertension. These risk factors play a significant role throughout the spectrum of all ages of onset of T2DM and must be addressed to delay the onset of T2DM.

Limitation of study: - The possibility of sample bias cannot be ruled out, as study was done on basis of people's recall.

Conflict of interest: - Declare that there is no conflict of interest that could be perceived as prejudicing the impartiality of the research reported.

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Research Article

Correlation between Blood Sugar Parameters and Lipid Profile Parameters Among Type 2 Diabetes Mellitus Patients

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ABSTRACT:

Background: The relationship between dyslipidemia and diabetes is particularly significant, as hyperglycemia not only induces apoptosis in the β-cells of the islets of Langerhans but also influences the extent of oxidized low-density lipoprotein (LDL) accumulation. Hence; the present study was conducted for assessing correlation between blood sugar parameters and lipid profile parameters among type 2 diabetes mellitus patients.

Materials & Methods: A detail history was taken and a complete physical examination and clinical evaluation of each subject was done and details were entered in the pre-designed proforma. Patients diagnosed as diabetes Mellitus according to ADA criteria were included in the present study. Serum Triglycerides, Total cholesterol and HDL cholesterol were analyzed by enzymatic methods with the help of Glaxo kits on ERBA Chem-5. Serum LDL cholesterol was calculated by Frederickson-Friedwald's formula according to which LDL cholesterol = Total cholesterol - (HDL cholesterol + VLDL cholesterol). VLDL cholesterol (VLDL-C) was calculated as 1/5 of Triglycerides. All the results were recorded in Microsoft excel sheet and was subjected to statistical analysis using SPSS software.

Results: The highest frequency of subjects was in the 51-60 age group (66 subjects, 33.0%) followed by the 41-50 age group (58 subjects, 29.0%).It was revealed that there exist significant correlations between HBa1c and TC ($r = .689$, $p < 0.01$) HBa1c and TG ($r = .581$, $p < 0.01$) and HBa1c and LDL ($r = .579$, $p < 0.01$).

Conclusion: Diabetes mellitus is one of the most serious global health problems.To conclude, the results of this study revealed a strong positive relationship betweenHbA1c and TC, TGs, and LDL, while showing a negative relationship with HDL and FBS, PPBS.

KEY WORDS: Diabetes Mellitus, Lipid, Blood sugar, LDL, HDL

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INTRODUCTION:

Type 2 Diabetes Mellitus (T2DM), a common metabolic disorders, results from a combination of two primary issues: reduced insulin secretion by pancreatic β-cells and the inability of insulin-sensitive tissues to respond properly to insulin. Since insulin release and function are essential for regulating glucose balance, the molecular mechanisms controlling insulin production, secretion, and receptor binding are tightly regulated. Any disturbance in these processes can lead to a metabolic imbalance, playing a role in the development of the disease.[1-3]

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As the disease progresses, insulin secretion becomes insufficient to sustain glucose homeostasis, resulting in hyperglycaemia. Patients with T2DM are typically identified by obesity or an increased body fat percentage, with fat primarily concentrated in the abdominal area. In this condition, adipose tissue contributes to insulin resistance (IR) by triggering multiple inflammatory pathways, such as elevated free fatty acid (FFA) release and disrupted adipokine regulation. The primary factors fueling the T2DM epidemic include the worldwide increase in obesity, physical inactivity, high-calorie diets, and an aging population, all of which have led to a fourfold rise in the disease's incidence and prevalence.[4,5]

High BG levels are linked to dyslipidemia. The connection between dyslipidemia and diabetes is especially important, since hyperglycemia not only causes β-cell apoptosis in the islets of Langerhans-a process known as glucotoxicity-but also affects the buildup of oxidized low-density lipoprotein (LDL). Furthermore, managing blood lipid levels can effectively mitigate the negative consequences of this condition.

It is noteworthy that over 75% of individuals with T2DM exhibit mixed dyslipidemia, which is characterized by reduced levels of high-density lipoprotein cholesterol (HDL-C) and elevated triglyceride (TG) levels.[6- 8] Therefore, this study was carried out to evaluate the relationship between blood sugar levels and lipid profile parameters in patients with T2DM.

MATERIALS & METHODS:

This cross-sectional, observational, hospital-based study was carried out in the Department of Internal Medicine at People's College of Medical Sciences & Research Centre, Bhopal, involving T2DM patients over an 18-month period, following approval from the institutional ethics committee. The patients were informed about the study and a written consent was obtained from each participant. A detailed medical history was recorded, and each subject underwent a thorough physical examination and clinical evaluation, with the findings documented in a pre-designed proforma. Patients diagnosed with diabetes mellitus (DM) based on ADA criteria—defined as having a fasting blood glucose (FBG) level over 126 mg/dL and/or a postprandial blood sugar (PPBS) level exceeding 200 mg/dL—were included in this study. Individuals with nephropathy, liver disease, or hypothyroidism were excluded. For laboratory analysis, 5 ml of fasting venous blood was drawn aseptically from the antecubital vein of each participant into plain vials for assessing FBG and lipid profile. A second blood sample was collected two hours after a meal to measure PPBG and HbA1c levels. The blood was then centrifuged, and the serum was separated for lipid profile analysis. Serum triglycerides (TG), total cholesterol (TC), and HDL cholesterol (HDL-C) were measured using enzymatic methods, utilizing Glaxo kits on the ERBA Chem-5 analyzer. Serum LDL cholesterol (LDL-C) was determined using the Friedewald formula, which calculates LDL-C as: Total cholesterol minus the sum of HDL cholesterol and VLDL cholesterol. VLDL cholesterol (VLDL-C) was estimated as one-fifth of the triglyceride value. All data were documented in a Microsoft Excel sheet and analyzed statistically using SPSS software.

RESULTS:

The highest proportion of participants fell within the 51–60 age group (66 individuals), followed by those aged 41–50 years (58 individuals). The smallest age groups were 21–30 years (1 individual) and over 70 years (19 individuals). Most participants had been living with diabetes for less than 5 years (118 individuals), followed by those with a duration of 6–10 years (42 individuals). The fewest had diabetes for more than 15 years (13 individuals).The results are depicted in Table 1.Analysis of lipid profile parameters among the study participants showed that 53.0% (106 individuals) had abnormal LDL levels, while 47.0% (94 individuals) had normal LDL. Triglycerides exhibited the highest rate of dyslipidemia at 45.0%, whereas total cholesterol showed the lowest at 35.0%.Table 2 presents the correlation between BG parameters and lipid profile components among the study participants. The results demonstrated significant positive correlations between HbA1c and total cholesterol ($p< 0.01$), HbA1c and triglycerides ($p< 0.01$), and HbA1c and LDL cholesterol ($p< 0.01$).

Graph 1: Age-wise distribution.

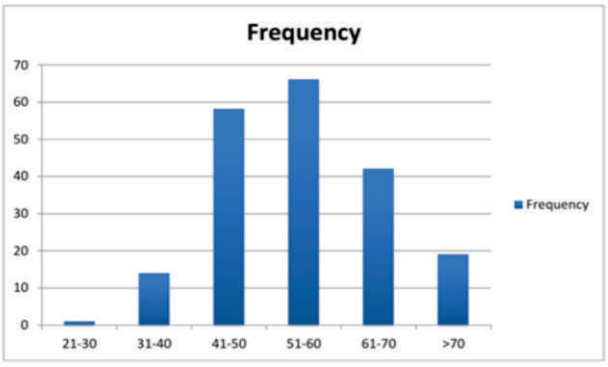

Table 1: Distribution of patients according to duration of diabetes.

Duration of Diabetes	Frequency	Percent
<5	118	59.0
6-10	42	21.0
11-15	27	13.5
>15	13	6.5

Table 2: Correlation between blood sugar parameters and lipid profile parameters among study subjects

		FBS	PPBS	HBalc	TC	TG	HDL	LDL
FBS	r value	1	.103	.034	-.058	.030	-.043	-.063
	p-value		.145	.628	.413	.678	.545	.328
PPBS	r value	.103	1	.079	.143 *	.082	-.007	.137
	p-value	.145		.264	.043 *	.249	.919	.054
HBalc	r value	.034	.079	1	.689 **	.581 **	.062	.579 **
	p-value	.628	.264		.000	.000	.387	.000
TC	r value	-.058	.143 *	.689 **	1	.607 **	.134	.884 **
	p-value	.413	.043	.000		.000	.058	.000
TG	r value	.030	.082	.581 **	.607 **	1	.010	.415 **
	p-value	.678	.249	.000	.000		.888	.000
HDL	r value	-.043	-.007	.062	.134	.010	1	-.005
	p-value	.545	.919	.387	.058	.888		.939
LDL	r value	-.063	.137	.579 **	.884 **	.415 **	-.005	1
	p-value	.378	.054	.000	.000	.000	.939	

*. Correlation is significant at the 0.05 level (2 – tailed).

**. Correlation is significant at the 0.01 level (t – tailed).

DISCUSSION:

T2DM is a chronic condition where elevated blood sugar levels are closely linked to increased risks of heart attacks, strokes, microvascular complications, and death. The progression of the disease is mainly marked by reduced β-cell function and increasing insulin resistance. Clinically, this is reflected in the worsening of several indicators such as A1C, fasting plasma glucose (FPG), and postprandial glucose levels. β-cells are unable to compensate for impaired glucose tolerance. This dysfunction seems to be linked to both decreased insulin output from individual islets and a decline in the overall number of islets. The gradual deterioration of β-cell function, along with a smaller reduction in β-cell mass, contributes to poor glycemic control and the onset of complications. While existing treatments help reduce BG levels, they do not fully prevent the ongoing decline in β-cell function and are often linked to side effects such as hypoglycemia and weight gain.[8-10]

The highest frequency of subjects was in the 51-60 age group (33.0%) followed by the 41-50 age group (29.0%) The least number of subjects were in the 21-30 age group (0.5%).The highest dyslipidemia was observed in TG (45.0%) and the lowest in TC (35.0%).The correlation between blood sugar parameters and lipid profile parameters among study subjects results revealed significant correlations between HBa1c and TC (r =0.689) HBa1c and TG (r = 0.581) and HBa1c and LDL (r = 0.579). Wang L et al investigated the relationship between BG levels and lipid profiles or lipid ratios in a group of patients with T2DM. Their analysis included a total of 1,747 individuals diagnosed with T2DM. There was a positive association between BG and TG levels; every 1 mmol/L increase in BG levels resulted in a 0.34 mmol/L increase in TG. BG levels were also associated with high LDL, TG/HDL-C levels. After adjusting for demographic factors, health behaviors, and physical health indicators, the study found a positive correlation between BG levels and both TG and LDL-C levels, as well as an increase in the TG/HDL-C ratio. Their findings confirmed a link between BG levels and serum lipids or lipid ratios, showing that higher glucose levels

were associated with elevated TG, LDL-C, and increased TG/HDL-C and LDL-C/HDL-C ratios.[9]

The results of this study are consistent with previous research showing a positive relationship between BG levels and both TG and LDL-C, which are linked to a higher risk of obesity and cardiovascular disease. In the context of T2DM, maintaining good glycemic control may contribute to improved lipid profiles. A previous study showed that short-term intensive glycemic control can significantly lower TG levels in individuals with T2DM. Another study highlighted the importance of controlling blood lipid levels in maintaining proper BG regulation among individuals with T2DM. Moreover, high BG levels are associated with an increased risk of obesity, which in turn influences lipid levels and their ratios.[10-13]

Stamouli M and colleagues analyzed serum samples from 800 patients with T2DM over a three-year period, along with 200 age-matched individuals without a clinical history of diabetes. Among the diabetic patients, 70.0% exhibited at least one lipid abnormality. Specifically, elevated levels of LDL-C, TCHOL, and TRG, as well as decreased HDL-C levels, were observed in 28.37%, 36.37%, 39.01%, and 30.12% of cases, respectively. The most common combination of lipid abnormalities was elevatedTRG alongside reduced HDL-C levels. Additionally, significant gender-based differences were found in HDL-C, TCHOL, TG, and GLU levels. However, no significant difference was observed in GHbA1c levels between men and women. The study also identified a strong linear correlation between LDL-C and TCHOL.[14]

CONCLUSION:

Diabetes mellitus represents a major global health challenge. In conclusion, this study demonstrated a strong positive correlation between HbA1c and TCHOL, TGs, and LDL, while revealing a negative association with HDL, FBS, and PPBS.

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Nil.

Conflicts of Interest
There are no conflicts of interest.

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Research Article

Correlation of Serum Uric Acid Levels and Type-2 Diabetes Mellitus in A Tertiary Care Hospital

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ABSTRACT:

Background: Type 2 diabetes mellitus (T2DM) is associated with insulin resistance, metabolic syndrome, and oxidative stress. Serum uric acid (SUA) levels have been linked to T2DM, but the relationship remains unclear. This study was aimed to assess the association between SUA levels and duration of diabetes, glycemic control (HbA1c), and markers of metabolic syndrome in patients with T2DM.

Materials &Methods: This hospital-based cross-sectional observational study included patients with T2DM aged ≥18 years, attending the OPD of General Medicine department. Patients with renal disorders, uricosuric drugs, renal calculi, chemotherapy, or unwilling participants were excluded.

Results: Mean age was 51.69±15.104 years, with 55.6% females. Mean duration of diabetes was 11.55±6.47 years in patients with normal SUA levels and 10.70±7.09 years in those with increased SUA levels. Significantly higher proportions of cases with raised SUA levels had HbA1c >8.5% (66.2% vs. 49.3%), whereas normal SUA levels had HbA1c <7.5% (31.3% vs. 11.7%). The association between SUA and HbA1c was statistically significant.

Conclusion: This study suggests a positive correlation between serum uric acid levels and poor glycemic control in patients with type 2 diabetes mellitus.

KEY WORDS: Serum Uric Acid; Type 2 Diabetes Mellitus; Glycemic Control; Metabolic Syndrome; Insulin Resistance.

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INTRODUCTION:

Chronic hyperglycemia as a result of diabetes leads to various metabolic aberrations, causing damage to various organ systems, leading to microvascular as well as macrovascular complications.[1] Diabetes is associated with certain risk factors such as advancing age, physical inactivity, unhealthy diet, obesity, family history etc.[2] The key risk factors associated with diabetes are insulin resistance and metabolic syndrome. The insulin resistance could be attributed to production of reactive oxygen species (ROS) as a result of oxidative stress, which is postulated to be a major link for beta cell dysfunction, as well as impaired glucose tolerance in type 2 diabetes mellitus (T2DM).[3,4] Apart from this, free radicals are formed and as a preventive measure, the generation of antioxidants in the body is increased.[5]

Uric acid, the end product of purine metabolism is one of the most abundant antioxidant in the plasma.[6] Uric acid can act as an antioxidant as well as strong reducing agent and has free radical scavenging property.[7] Hyperuricemia may be due to overproduction of urate, the soluble form of uric acid or

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its decreased elimination, or both. Raised serum uric acid levels and deposition of urate is seen in certain conditions such as gout, acute and chronic nephropathy, urolithiasis etc.[8] There is also an increasing evidence suggesting possible link between hyperuricemia and various disorders including diabetes, obesity, hypertension, dyslipidemia, insulin resistance, inflammation, cardiovascular diseases and peripheral vascular diseases.[9-16]

Though a causal relationship between hyperuricemia and diabetes is not established, three mechanisms have been postulated suggesting the positive association between diabetes and raised uric acid concentration. First, metabolic syndrome associated with diabetes induces high oxidative stress, and raised serum uric acid levels further worsens this condition. Second, uric acid act as stimulator for proliferation of vascular smooth muscles, leading to endothelial dysfunction. Third, increased renal glomerular pressure in cases with hyperuricemia affect the sodium reabsorption in kidneys.[17] Further, literature suggest that fructose increases the production of uric acid, promoting insulin resistance and T2DM rapidly.[18]

A positive link between diabetes and uric acid levels have been reported by few of the previous studies conducted in Western countries. Measurements of serum uric acid levels may be of help in patients with diabetes mellitus if it is shown to be correlated with worsening of diabetes mellitus (DM). The present study was therefore conducted at a tertiary care centre to study the association of serum uric acid levels with duration of DM and Diabetes control (HbA1c) as well as to correlate serum uric acid level with markers of metabolic syndrome in diabetic patient.

MATERIALS & METHODS:

The present study was conducted as a hospital based cross sectional observational study on patients with DM attending the OPD of Medicine and Endocrinology department, People's College of Medical Sciences and Research Centre & associated People's Hospital Bhopal, during the study period of 18 months i.e. from 01 November 2022 to 30 April 2024. The present study included patients with T2DM aged 18 years or older who provided informed consent. Excluded were patients with renal disorders, those taking uricosuric drugs, or with a history of renal calculi, chemotherapy, or unwilling participants, as well as individuals under 18. Written consent was obtained from all the study participants in consent form, after explaining them nature and purpose of study with the help of participant's information sheet. The patients were ensured that confidentiality will be maintained and option to withdraw from the study was always kept open.

After obtaining ethical clearance from Institute's ethical committee, all the patients with T2DM satisfying the inclusion and exclusion criteria were enrolled. Detailed history regarding socio-demographic variables such as age, gender, etc. was obtained and entered in prescribed questionnaire. All the patients were then subjected to detailed clinical history, which included data regarding mode of presentation, duration of symptoms, duration of diabetes etc. History regarding diabetic medications, insulin, comorbid conditions along with past medical and surgical history if any was obtained and entered in the questionnaire. All the patients were then subjected to general physical and systemic examination. Their height and weight were obtained and BMI was calculated. Apart from this, waist hip ratio and blood pressure were obtained for all the cases.

All the patients were then subjected to blood investigations, for which 2 ml venous blood was collected in EDTA tubes and plain tube under all aseptic precautions. The blood obtained was subjected to analysis of serum uric acid level and HbA1c. The presence of serum uric acid level above 7 mg/dl and 6 mg/dl was considered hyperuricemia for males and females respectively.

Data was collected and analysis was done using IBM SPSS software version 20. Categorical variables were expressed as frequency and proportion whereas continuous data was expressed as mean and standard deviation. Association of uric acid levels with duration of diabetes, HbA1c levels and components of metabolic syndrome was done using Chi square test (for categorical variables) or independent t test or ANOVA (for continuous variables). Correlation of uric acid levels with various diabetic parameters was done using Pearson Correlation Coefficient and was interpreted as *p*-value of less than 0.05 was considered statistically significant.

RESULTS:

In present study, mean age of patients with T2DM was 51.69±15.104 years and majority i.e. 27.8% cases belonged to 51 to 60 and more than 60 years of age. Only 11.1% cases belonged to 31 to 40 years whereas 12.5% cases belonged to less than 30 years of age (Table 1). In present study, more than half of the cases with T2DM were females (55.6%), whereas only 44.4% of the cases were males (Table 2). As observed from Table 3, mean duration of diabetes in patients with normal uric acid levels was 11.55±6.47 years

Table 1: Distribution of cases according to age.

Age (years)	Frequency (n=144)	Percentage
=30	18	12.5
31-40	16	11.1
41-50	30	20.8
51-60	40	27.8
>60	40	27.8
Mean±SD	51.69 ±15.104	

Table 2: Distribution of cases according to gender.

Gender	Frequency (n=144)	Percentage
Male	64	44.4
Female	80	55.6

whereas in cases with increased uric acid levels was 10.70±7.09 years. Majority of cases had duration of diabetes in the range of 6 to 15 years irrespective of serum uric acid levels (p>0.05). Mean body mass index in patients with normal uric acid levels was 25.055±3.46 whereas in cases with increased uric acid levels was 24.46±3.29 kg/m2. Majority of cases with normal as well as increased serum uric acid levels were obese (49.3% and 42.9%) and the observed association of uric acid with BMI was statistically insignificant (p>0.05) (Table 4).

Mean WHR in patients with normal uric acid levels was 0.88±0.13 whereas in cases with increased uric acid levels was 0.86±0.12. Majority of cases with normal as well as increased serum uric acid levels had high WHR (64.2% and 55.8%) and we found no significant association of uric acid with waist hip ratio (p>0.05) (Table 5).

In present study, significantly higher proportions of cases with raised serum uric acid levels had raised HBA1c above 8.5% (66.2% vs. 49.3%), whereas significantly higher proportions of cases with normal uric acid levels had HbA1c values below 7.5% (31.3% vs. 11.7%). The observed association of serum uric acid levels with HbA1c was statistically significant (p<0.05) (Table 6).

Table 4: Association between serum uric acid levels and BMI.

Body Mass Index (kg/m2)	Uric Acid			
	Normal(n=67)		Increased(n=77)	
	n	%	n	%
Underweight	1	1.5	2	2.6
Normal	14	20.9	23	29.9
Overweight	19	28.4	19	24.7
Obese	33	49.3	33	42.9
Mean±SD	25.055 ±3.46		24.46 ±3.29	
X^2	1.84			
p-value	0.61			

Table 5: Association between serum uric acid levels and Waist hip ratio.

Waist Hip Ratio	Uric Acid			
	Normal(n=67)		Increased(n=77)	
	n	%	n	%
Normal	24	35.8	34	44.2
Increased	43	64.2	43	55.8
Mean±SD	0.88 ±0.13		0.86 ±0.12	
X^2	1.04			
p-value	0.31			

DISCUSSION:

This hospital based observational analytical, cross-sectional study examined the link between uric acid and diabetes in 144 patients with T2DM, who attended the OPD of Medicine and Endocrinology department of a tertiary care hospital at Bhopal, India. The average patient age in the early sixth decade, with a slight female majority. Although most had diabetes for over 6 years, there was no connection between uric acid levels and duration of diabetes. Similarly, weight (measured by BMI) and waist-hip ratio did not show a

Table 3: Association between serum uric acid levels and duration of diabetes.

Duration Of Diabetes(years)	Uric Acid			
	Normal(n=67)		Increased (n=77)	
	n	%	n	%
=5	14	20.9	20	26.0
6-10	19	28.4	21	27.3
11-15	20	29.9	21	27.3
>15	14	20.9	15	19.5
Mean±SD	11.55 ±6.47		10.70 ±7.09	
X^2	0.53			
p-value	0.913			

Table 6: Association between serum uric acid levels and HbA1c levels .

HbA1c	Uric Acid			
	Normal(n=67)		Increased(n=77)	
	n	%	n	%
<7.5	21	31.3	9	11.7
7.5-8.5	13	19.4	17	22.1
>8.5	33	49.3	51	66.2
Mean±SD	9.09 ±2.09		10.08 ±2.65	
X^2	8.54			
p-value	0.014			

significant link with uric acid levels. Blood pressure readings also seemed independent of uric acid. However, an interesting finding emerged when we observed blood sugar control. Hemoglobin A1c (HbA1c) is a measure of long-term blood sugar management. Here, the study identified a weak positive correlation. Patients with higher uric acid levels tended to have higher HbA1c, indicating poorer blood sugar control in diabetics. While the association was not very strong, it suggests a potential link between uric acid and how well diabetes is managed.

Average uric acid level found in this study was 7.13 mg/dL. Over half of the patients tested (53.5%) had elevated uric acid levels. The serum uric acid levels were significantly increased in cases (8.41 ± 1.09) ($p<$ 0.001) as compared to control group (4.34 ± 0.66) in the study by Kaur J et al.[19] Similarly, Dhungana A et al investigated relationship between uric acid and blood sugar control in diabetes mellitus patients. They found 18.5% with hyperuricemia. They also found slightly higher uric acid in men than women. They found negative correlation between HbA1c, FBG, and PPBG in diabetes patients, suggesting potential inverse relationship. [20] Another alike study by Solanki HK et al found positive correlation between uric acid levels and diabetes duration with uric acid levels increased from 6.8 mg/dL to 7.7 mg/dL with longer diabetes duration (7-10 years).[21]

Kaire U et al reported average serum uric acid level of 5.10 mg/dL in T2DM patients.[22] Deb N et al found higher uric acid levels in diabetic patients vs. healthy controls and reported better blood sugar control associated with higher uric acid levels.[23] Modi AS et al detected lower serum uric acid levels in diabetic patients, but increased urinary uric acid excretion and positive correlation between blood sugar and urinary uric acid excretion was reported.[24] Deori R et al found high uric acid levels correlated with abnormal kidney function markers in diabetic and non-diabetic patients. This suggests high uric acid as potential early indicator of kidney problems.[25] In another study by Sidhu et al. (2017), diabetic patients had a uric acid level of 8 mg/dL, while healthy controls had a level of 3.7 mg/dL. [26]

Monitoring uric acid levels could hold value, especially in diabetic patients with additional risk factors for hyperuricemia (obesity, high blood pressure, etc.). However, more research is required to establish clear guidelines for uric acid monitoring frequency and target levels in diabetic patients. In the present study, a significant correlation between elevated serum uric acid levels and poor glycemic control, as measured by HbA1c values was reported. Specifically 66.2% of patients with high uric acid levels had HbA1c >8.5%, compared to 49.3% with normal uric acid levels, indicating a 34.6% increased likelihood of poor glycemic control. Conversely, 31.3% of patients with normal uric acid levels achieved optimal glycemic control (HbA1c <7.5%), compared to 11.7% with elevated uric acid levels, suggesting a 166% increased likelihood of better glycemic control. Our study stands in concurrence with other studies. A comparable study by Sidhu et al found significantly higher serum uric acid levels in T2DM patients compared to controls (8.02 mg/dL vs 3.73 mg/dL) suggesting monitoring uric acid levels could indicate oxidative stress in T2DM.[26] Similarly, Ullah A et al linked poorly controlled blood sugar to high uric acid levels in diabetic patients, particularly adults and found a significant association between high blood sugar and uric acid levels.[8] Another study by Nan H et al found decreasing uric acid levels over time in participants who developed diabetes and higher baseline uric acid levels associated with increased diabetes risk in men. [10] Swarnalatha JC et al. (2019) identified independent association between uric acid levels and fasting blood sugar, blood pressure, BMI, and alcoholism status suggesting link between hyperuricemia and T2DM with hypertension. [8] Bhole V et al found high uric

acid levels to be an independent risk factor T2DM, even after accounting for other risk factors.[27] Another study Rao S et al found pre-diabetic patients had higher serum uric acid levels (4.88 mg/dL) compared to controls (3.84 mg/dL) and diabetic patients (3.78 mg/dL).[28] Fazlani KA et al linked higher uric acid levels in diabetic patients to unfavorable lipid profiles recommends monitoring uric acid and lipid profiles.[29] Shirsath A et al found approximately two-thirds of T2DM patients had elevated uric acid levels.[30] Panchani M et al found significant positive correlation between uric acid levels and HbA1c and fasting blood sugar in Monitoring uric acid levels could hold value, especially in diabetic patients with additional risk factors for hyperuricemia (obesity, high blood pressure, etc.). However, more research is required to establish clear guidelines for uric acid monitoring frequency and target levels in diabetic patients. In the present study, a significant correlation between elevated serum uric acid levels and poor glycemic control, as measured by HbA1c values was reported. Specifically 66.2% of patients with high uric acid levels had HbA1c >8.5%, compared to 49.3% with normal uric acid levels, indicating a 34.6% increased likelihood of poor glycemic control. Conversely, 31.3% of patients with normal uric acid levels achieved optimal glycemic control (HbA1c <7.5%), compared to 11.7% with elevated uric acid levels, suggesting a 166% increased likelihood of better glycemic control. Our study stands in concurrence with other studies. A comparable study by Sidhu et al found significantly higher serum uric acid levels in T2DM patients compared to controls (8.02 mg/dL vs 3.73 mg/dL) suggesting monitoring uric acid levels could indicate oxidative stress in T2DM.[26] Similarly, Ullah A et al linked poorly controlled blood sugar to high uric acid levels in diabetic patients, particularly adults and found a significant association between high blood sugar and uric acid levels.[8] Another study by Nan H et al found decreasing uric acid levels over time in participants who developed diabetes and higher baseline uric acid levels associated with increased diabetes risk in men. [10] Swarnalatha JC et al. (2019) identified independent association between uric acid levels and fasting blood sugar, blood pressure, BMI, and alcoholism status suggesting link between hyperuricemia and T2DM with hypertension.[8] Bhole V et al found high uric acid levels to be an independent risk factor T2DM, even after accounting for other risk factors.[27] Another study Rao S et al found pre-diabetic patients had higher serum uric acid levels (4.88 mg/dL) compared to controls (3.84 mg/dL) and diabetic patients (3.78 mg/dL).[28] Fazlani KA et al linked higher uric acid levels in diabetic patients to unfavorable lipid profiles recommends monitoring uric acid and lipid profiles.[29] Shirsath A et al found approximately two-thirds of T2DM patients had elevated uric acid levels.[30] Panchani M et al found significant positive correlation between uric acid levels and HbA1c and fasting blood sugar in T2DM patients. [31] Farwa U et al found pre-diabetic patients had highest uric acid levels (6.07 mg/dL) compared to euglycemic and diabetic groups. [32]

However, in contrast to our study, Haque T et al reported higher serum uric acid levels in healthy individuals than pre-diabetics and diabetics and found negative association between uric acid and fasting blood glucose.[17] Dhungana A et al found negative correlation between uric acid and HbA1c, FBG, and PPBG in diabetes patients, suggesting potential inverse relationship.[20] Bandaru P et al (2011) found higher uric acid levels associated with lower diabetes risk, regardless of age, lifestyle, and health conditions. Highest uric acid group had nearly half the chance of diabetes. [33] Another study by Ganesh G et al found lower serum uric acid levels in diabetic patients vs. healthy controls, but difference was not statistically significant. No significant correlation between uric acid and blood glucose. [34]

Shabana S et al found hypertensive diabetics had lower serum uric acid levels than non-hypertensive diabetics and negative correlation between blood sugar and uric acid in diabetic patients.[35]

The possible reasons for Hyperuricemia worsening glycemic control could be either due to the oxidative stress or due to inflammation. High uric acid can act as a pro- oxidant, generating free radicals that damage pancreatic beta cells responsible for insulin production. This impaired insulin secretion can lead to hyperglycemia and contribute to poor glycemic control. Uric acid crystals can trigger inflammation in various tissues, including the adipose tissue and liver. [36] This chronic low-grade inflammation can impair insulin sensitivity in these tissues, further hindering blood sugar control.

Poorly controlled diabetes might also lead to hyperuricemia in the following manner. Firstly, poorly controlled diabetes with chronically elevated blood sugar levels can stimulate the production of uric acid through a process called purine nucleotide degradation. This increased production could overwhelm the body's uric acid excretion capacity, leading to hyperuricemia. Secondly, Diabetes can damage the kidneys over time, leading to decreased uric acid excretion. This impaired elimination, coupled with potentially increased production, could contribute to elevated uric acid

levels. Moreover, there are shared underlying metabolic pathways. Both hyperuricemia and hyperglycemia can be linked to insulin resistance, a condition where cells become less responsive to insulin's effects. This suggests potential shared metabolic pathways influencing both conditions. Increased dietary fructose intake has been linked to both hyperuricemia and insulin resistance. Fructose metabolism can generate precursors for uric acid production and impair insulin signaling, potentially contributing to the observed correlation. [9]

Other factors like genetic predisposition might influence both uric acid metabolism and insulin sensitivity, potentially creating a susceptibility to both hyperuricemia and poor glycemic control. Lifestyle factors like diet, physical activity, and body weight can influence both uric acid levels and diabetes management. These factors require further investigation to understand their potential role in the observed association.

The few limitations of the present study are that observed correlation does not clarify whether high uric acid levels contribute to poor glycemic control or vice versa. Patients with pre-existing risk factors for both hyperuricemia and hyperglycemia might have been recruited, leading to a spurious association. The study design does not account for potential confounding variables that could influence both uric acid and HbA1c. Factors like diet, physical activity, medications, and even socioeconomic status could play a role and need to be considered in future research designs that incorporate adjustments for these variables. Selection bias can occur if the study population avoids representing the broader diabetic population. Recruiting patients from a single tertiary care hospital might have enrolled individuals with more severe cases or those with specific characteristics that skew the results.

CONCLUSION :

To conclude, a significant association was found between raised serum uric acid levels and poor glycemic control (HbA1c >8.5%). Specifically, 66.2% of patients with hyperuricemia had HbA1c >8.5%, compared to 49.3% with normal uric acid levels. Conversely, 31.3% of patients with normal uric acid levels achieved optimal glycemic control (HbA1c <7.5%), compared to 11.7% with hyperuricemia. These findings suggest that serum uric acid levels may serve as a useful marker for identifying patients with type 2 diabetes mellitus at risk of poor glycemic control. Monitoring uric acid levels may aid in early detection and management of hyperglycemia, potentially reducing the risk of microvascular and macrovascular complications associated with diabetes.

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Conflicts of Interest

There are no conflicts of interest.

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Research Article

Study of Quality Control in Clinical Hematology Laboratory by Using Six- Sigma in a Medical College &Tertiary Care Center

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ABSTRACT:

Background: Clinical laboratories' unpredictable and counterfeit results have grave implications for patients. Sigma metrics is a standardized tool for assessing the quality of test results in a laboratory. The goal of quality control in the hematology laboratory is to make sure that reliable test findings are created with the vital precision and accuracy. The quality control system aims to keep record and track the analytic processes, identify investigative errors during the process of analysis, and prevent inaccurate patient values. Six σ is a distinguished quality management approach that employs statistical tool or methods to identify removable flaws and variations of observations .In this immediacy of the research gap, the study was undertaken to evaluate the quality of the analytical performance of clinical hematology in laboratories by calculating sigma metrics.

Materials & Methods: The study was conducted at Central Clinical Laboratory, NKP SIMS RC & LMH Nagpur. Internal quality control (IQC) datasets of 5 analytes were analyzed retrospectively in 2 months from May 2023 to June 2023 by using Advia -2120 - 5 Part Cell Counter. The analytics were assessed for red blood cell (RBC), hemoglobin (Hb), hematocrit (HCT), platelet (PLT) and white blood cell (WBC) etc.

Results: The highest coefficient of variation percentage (CV %) value was 8.7% for platelet and the lowest was 0.93 % for Hb. The highest Bias percentage value was 6.5% in Hb and the lowest was 1.70 % for WBC. In case of IQC, Hb, WBC, RBC, HCT, PLT the criteria sigma value for world class performance was seen in Hb & HCT, good to excellent performance in RBC &WBC, poor performance for PLT.

Conclusion: The Advia -2120 - 5 Part Cell Counter would be excellent, with an expressive range of 5 to > 6 sigma values. The accuracy performance is more suitable for routine examination of research intervention, because of its accuracy and reproducibility, the imprecision is within acceptable levels. However, the low sigma expression is an indication for Vigorous monitoring and Corrective and Preventive Action (CAPA) will be implemented by advice.

KEY WORDS: IQC, analytical errors, hematological parameters, six sigma

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INTRODUCTION:

Quality is defined as conformance to the requirements of the end users [1,2]. Quality Control (QC) aims at immediate detection of an error by monitoring the accuracy and precision of the analytical processes. Implementation of QC is a continuous dynamic process to ensure that test results produced by the laboratory are reliable. Sigma in statistics is used to represent the Standard deviation (SD), which is an indicator of the degree of variation in a set of processes. Sigma measures how far a given process deviates from perfection and it is a popular quality management system tool employed for process improvement. Evaluation of errors in terms of sigma metrics is more meaningful than number of defects alone. For analytical process of laboratory system, sigma metric analysis identifies the errors in quality indicators of the process and provides correction of errors on the basis of results[3].The clinical laboratories serve as critical responsibility in helping and saving the lives of patients and also to increase patient well-being and efficiency of inpatient care. The right tests must be chosen, and the test results will be trustworthy and we can appropriately interpret the results to enhance efficiency in patient care and improve patient wellbeing. As a result, quality management policies should be applied as a routine aspect of patient care, not just as an analytical need.[4,5]

Hematology is one sort of laboratory investigations. Moreover; the study of morphology of the produced constituents of the blood, as well as the morphology of the bone marrow, spleen, and lymphoid organs is the focus of hematology.[6] Laboratory errors have a major impact on patient care quality.[3] Previous Studies have found that there is a 2.7%–13% chance of an adverse event occurring as a result of a laboratory errors.[7,8] Automated techniques are being used in many laboratories, techniques are more exact than manual or semi-automated approaches, but their precision is dependent on the proper calibration and the use of reagents that are usually unique to the analyzer.[9] However, the QC should be applied to all examination techniques.[6] Autovalidation and auto reporting are becoming increasingly important.[10]

The laboratory's ultimate evaluation will be based on its quality. Advanced and aesthetically pleasing software should be used to help improve the quality.[11] The selection of appropriate Internal quality control (IQC) material is critical to the success of a QC method.[11] First, to minimize matrix effects on analytes measurement, IQC material should strongly match the makeup of patient samples.[8] 3-Sigma performance is considered the minimum in any industrial process. The typical performance of a business or industry process is considered to be around 4- Sigma.

The first goal of a Six Sigma project in business and industry is usually to improve from 4-Sigma to 5-Sigma. This is a very significant improvement: a 100-fold reduction in defects in short term. Some processes never reach 6-Sigma. But reaching 5-Sigma may be good enough. A sigma score of six indicates that the assay performance is optimal and thus efforts to further improvement in the quality are unwarranted. In some cases, the process can be re-engineered to achieve 6-Sigma performance.[8,12] Six sigma provides an easy way to talk about different process by using a common mathematical framework.[9] In this propinquity of the research gap, the present study aims to correlate the sigma metrics of clinical chemistry analytes and plan the QC strategy.

Further, we determine the total permissible error in clinical laboratory and correlate the findings by the use of CLIA guidelines (thereby evaluate the functioning of the instrument as well as the adequacy of the methodology being followed).

MATERIALS & METHODS:

The study was conducted at Central Clinical Laboratory, NKP SIMS RC & LMH Nagpur. IQC datasets of 5 analytes were analyzed retrospectively in 2 months from May 2023 to June 2023 by using Advia - 2120 - 5 Part Cell Counter. The analytics were assessed for red blood cell (RBC), hemoglobin (Hb), hematocrit (HCT), platelet (PLT) and white blood cell (WBC) etc. QC material Level-1, Level-2 & Level-3 were assayed before analyzing patient's samples every day. E- check QC material belonged to R&D systems (CBC-3D) and QC values were obtained based on the standard reference method. The instrument was calibrated and maintained regularly. IQC datasets were obtained from the IQC document laboratory. If erring (Violating Westgard Rule) values arose from the sample of control, the values were eliminated and rectified by control.

The study was approved by institutional ethical clearance.

IMPRECISION:

Imprecision (random error) is determined from a replication experiment during method validation studies or SQC data collected during routine operation. The Labs performed verified replication experiments, the precision was cross checked and then monitor ongoing performance from SQC data collected under the conditions of routine operation (Westgard & Westgard, 2006). An imprecision expressed routine operation (Westgard & Westgard, 2006). An

imprecision expressed values was modeled as coefficient of variation (% CV), it was determined from the calculated mean and standard deviation evaluated from the IQC data. The CV is the ratio of SD to the actual mean obtained from the data set.

CV % = (SD/mean) x100

BIAS: Bias was calculated as the percentage difference of the average of observed results on each analytes from the target values which was provided from the control package inserts. Percent bias values in each test was determined separately between May2023- June 2023.This can be summarized by the following formula

% BIAS = [(our laboratory mean of IQC data-target mean of IQC data)/target mean of IQC data] ×100.

TOTAL ALLOWABLE ERROR:

In 1974, Westgard was the first to propose the concept of total error (TE). A single measure of the uncertainty of a test result was created by combining analytical imprecision and bias i.e., systematic error (SE).[13] Total allowable error (TEa) is the total allowable difference from the accepted reference value seen in the deviation of a single measurement from the target value. Standardized TEa values of various parameters were taken from Clinical Laboratories Improvement Act (CLIA) guidelines.

TEa observed in this assay was calculated using the formula –

TEa observed = bias + % CV* 2. Thus, observed TEa was compared with CLIA guidelines.

SIGMA:

Sigma (s) value was used to determine the analytical performance characteristic of sigma value tested by using CV (obtained from IQC data), Bias %, and TEa values. Sigma value is calculated using the standard equation: Sigma (σ)= (TEa-Bias) / CV.

A sigma score of 6 indicates that, the assay's performance is ideal and further improvements are unlikely. Assays with a sigma value of 4–6 are considered adequate and have reasonable level of quality and accuracy, while those with a sigma score of 3–4 are considered unsatisfactory.

For an assay with a sigma metric of less than 3, no amount of IQC provides adequate error detection rates; therefore efforts should be focused on enhancing the test's quality. We should improve the precision of the assay, duplicate or triplicate analysis may be used.[8]

RESULTS:

Descriptive statistics like mean, SD, CV, and Sigma Value IQC data of 5 analytes were analyzed retrospectively in 2 months (May and June 2023) by using quality control data result with Advia 2120i hematology Analyser. The mean, SD, CV (%), bias, and sigma values for all 5 analytes were calculated. Results are presented in the (Table 1,2,3,4) and (Graph1). A sigma level<3 is an indication of a poor performance procedure (i.e. Non acceptable, No amount of IQC provided appropriate errors detection rate), sigma level 3- 4 is an indication of marginal performance (i.e. Unsatisfactory), sigma level 4 – 6 is an indication good to excellent performance (i.e. Adequate) and above six sigma level is a world-class performance (i.e. Ideal).[8]

DISCUSSION:

QC is used to evaluate the examination (analytic) phase of testing as part of the quality management system. Before patient results are presented, the purpose of QC is to detect, assess, and fix errors caused by test system malfunction, environmental circumstances, or operator performance etc.[14] Internal and external quality controls are investigated at various levels to determine the precision and accuracy of laboratory tests of clinical laboratories. When evaluating internal quality, Westgard standards are applied. Analytical procedures' performance is monitored using quality control materials.[6] The role of quality control in clinical laboratories is well-established.[15] IQC practice, on the other hand, differs greatly between laboratories. Standardization of procedures to IQC material selection, target and range assignment, statistical rule application, IQC review, and troubleshooting will improve the quality of results and ease pathology service standardization.[8]

The analytical phase accounts for 7%–13% of all errors in the entire testing process. IQC procedures are critical for discovering errors in the analytical phase and thus enhancing patient care quality.[16] Commutability, correctness of analytes concentration, stability, vial-to-vial & lot-to-lot verification variability should all be considered when choosing an IQC material. Ideal QC material should have long stability and matrix same as patient sample.[17] Target values and ranges should be assigned locally. Material for IQC should come from a third- party resource and not be the same as that utilized for calibration. IQC samples should be treated in the same way as patient samples are.[8]

The sigma values <3 i.e. for PLT, HCT, upgraded analyzers and better methodologies may help in achieving sigma values. This was in comparison with the other studies done by Usha Adiga et. al where the sigma score was very less for few parameters.[18] For

Table1:Descriptive Statistics of P.Q.C. May. 23

SN	Parameter	Target	Mean	SD%	CV%	Bias%	TEa%	Sigma
1	Hb	13.80	12.90	00.12	00.93	06.50	07.10	05.37
2	WBC	08.04	08.20	0198	02.41	01.70	15.00	05.50
3	RBC	04.71	04.60	00.04	00.86	04.40	06.00	01.86
4	HCT	40.30	42.80	00.70	01.75	04.70	06.00	07.40
5	PLT	258.0	03.72	00.30	08.70	04.40	25.00	02.80

Table 2: Descriptive Statistics of P.Q.C. June. 23

SN	Parameter	Target	Mean	SD%	CV%	Bias%	TEa%	Sigma
1	Hb	13.70	13.20	00.46	03.50	04.30	07.1 0	08.00
2	WBC	08.05	07.50	112.0	14.90	06.60	15.00	05.60
3	RBC	04.71	04.90	00.06	01.20	01.90	06.00	03.40
4	HCT	40.30	43.90	00.96	02.00	09.10	06.00	02.70
5	PLT	02.59	02.60	00.35	13.50	07.00	25.00	01.80

Table 3: Six Sigma distribution & Internal Quality Control Performance Quality Control for May: 23

SN	Parameter	CV%	Bias%	TEa%	Sigma	Note
1	Hb	00.93	06.50	07.10	05.37	Good to Excellent Performance
2	WBC	02.41	01.70	15.00	05.50	Good to Excellent Performance
3	RBC	00.86	04.40	06.00	01.86	Poor Performance
4	HCT	01.75	04.70	06.00	07.40	Good to Excellent Performance
5	PLT	08.70	04.40	25.00	02.80	Poor Performance

Table 4: Six Sigma distribution & Internal Quality Control Performance Quality Control for June: 23

SN	Parameter	CV%	Bias%	TEa%	Sigma	Note
1	Hb	03.50	04.30	07.1 0	08.00	Good to Excellent performance
2	WBC	14.90	06.60	15.00	05.60	Good to Excellent performance
3	RBC	01.20	01.90	06.00	03.40	Good to Excellent performance
4	HCT	02.00	09.10	06.00	02.70	Poor Performance
5	PLT	13.50	07.00	25.00	01.80	Poor performance

less than 3 sigma, method performance must be improved before the method can be used for routine production. A method with a sigma of less than 3 necessitates method modification as the test's quality improves even after multiple QC runs, assurance cannot be guaranteed. As a result, sigma metrics values can be useful in a variety of situations establishing IQC acceptance criteria.[18] The six sigma scale is evaluated between 0-6 and may exceed more than 6 in case of low variability. In the result obtained from the observation study the parameter HB, WBC, RBC are showing good to excellent performance, hence two levels of QC per day has been run following 1;2.5s rule. HCT has marginal performance and use of a combination of rules with two levels (Westgard rules) of QC twice per day has been run, however, PLT has

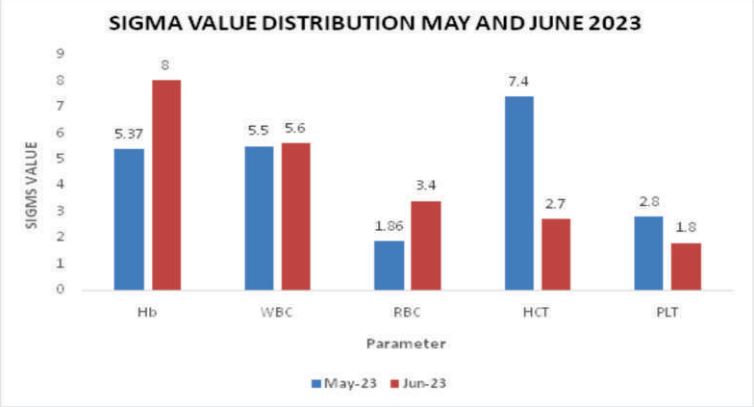

Figure : Six Sigma distribution for May &June: 23

poor performance as per six sigma, hence low six sigma calls for more vigorous monitoring and CAPA.[12]

According to Cooper et al, 3s (problems), should be corrected with maximum QC, which is run three levels, three times a day and considers testing specimens in duplicate. 3s–4s (poor performers) should use a combination of rules with two levels of QC twice per day. 4s–6s (suited for purpose) should be evaluated with two levels of QC per day and the 1:2.5 s rules. 6s (excellent tests) should be evaluated with one QC per day (alternating levels between days) and follow 1:3.5 s rule.[7]

CONCLUSION:

Grading laboratory errors according to their severity should aid in identifying quality improvement priorities and encourage a focus on corrective/ preventive efforts. It's crucial to examine, not only the actual patient injury but also the worst-case scenario if an error happens. Sigma metrics help us to assess analytical methodologies and augment laboratory performance. It acts as a guide for planning a quality control strategy. It can be a self-assessment tool regarding the functioning of a clinical laboratory. Specific limitations of the study is that this is only a pilot project to understand the significance of the six Sigma metrics application for total quality management of the laboratory. Further, these studies involve a wide range of parameters over an extended period which is being recommended for a significant conclusion.

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Conflicts of Interest

There are no conflicts of interest.

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Research Article

Exploring the Correlation between Tobacco Forms and Oral Health among Tribal Communities in Jharkhand

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ABSTRACT:

Background: In Jharkhand, India, tobacco usage is widespread among tribes, which presents serious problems for oral health. The prevalence of oral mucosal lesions, dental caries, and overall oral hygiene status in this population was investigated in this study in relation to various forms of tobacco use.
Materials & Methods: 250 members of Jharkhand's tribal communities participated in this cross-sectional survey. Structured interviews were used to gather information on tobacco use, including both smoked and smokeless forms. Clinical examinations evaluated were, oral hygiene status (using the OHI-S index), dental caries (using the DMFT index), and the prevalence of oral mucosal lesions. ANOVA for continuous variables and chi-square tests for categorical data were used in the statistical analyses, with significance set at $p<0.05$.
Results: Thirty percent of the 250 individuals said they used tobacco. Compared to smokers (3.8%) and non-users (0.7%), smokeless tobacco users (9.4%) had a substantially greater prevalence of oral mucosal lesions ($p<0.01$). With higher scores seen in tobacco users, the mean DMFT score was 2.4 ± 1.6, indicating a moderate prevalence of dental caries. The OHI-S results showed that tobacco users had worse oral hygiene than the rest of the sample.
Conclusion: Among Jharkhand's tribes, tobacco use—particularly smokeless tobacco—is closely linked to increased prevalence of oral mucosal ulcers and poor oral health. These results highlight the necessity of focused public health initiatives that encourage tobacco cessation and promote dental health.

KEY WORDS: Tobacco, Oral Health, Oral Mucosal Lesions, Dental Caries, Oral Hygiene, Tribal Communities, Jharkhand.

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INTRODUCTION:

Tobacco use in all of its forms is a widespread and serious public health concern, especially among tribal groups like those in Jharkhand, India. Attempts to lessen tobacco's negative health effects are made more difficult in these cultures since tobacco use is frequently ingrained in cultural customs. In order to highlight the particular difficulties and factors that must be taken into account for successful health interventions, this study investigates the precise association between various tobacco use patterns and the frequency of oral mucosal lesions among Jharkhand's tribal populations.

Tribal groups of Jharkhand are distinguished by their unique cultural identities and customs, one of

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which is the widespread use of tobacco, which ranges from smoked forms like cigarettes and bidis to smokeless forms like gutkha and khaini[1]. Mucosal lesions, which are precursors to more serious oral diseases like cancer, are among the disproportionately high prevalence of oral health problems brought on by these behaviours[2]. The need for a targeted study on these groups is highlighted by prior research showing that both smoked and smokeless tobacco considerably enhance the likelihood of acquiring such lesions[3].

The cycle of morbidity linked to tobacco smoking is further perpetuated by the absence of comprehensive healthcare services and health literacy in these areas, which increases the risk[4]. Research in other comparable tribal contexts throughout India has repeatedly emphasised the necessity for culturally relevant and easily accessible health interventions, indicating that customised strategies are essential for success[5]. This is especially important in Jharkhand, where seclusion and tribal customs pose special difficulties for traditional healthcare delivery systems [6].

This study will offer a detailed knowledge of the ways in which different tobacco products affect oral health among Jharkhand's tribal tribes thanks to its mixed-model methodology. The project intends to identify the precise behavioural patterns linked to tobacco use and their direct connections to health outcomes by combining quantitative and qualitative research approaches. The investigation of socioeconomic and cultural elements that impact tobacco use patterns will also be made possible by this dual strategy, which will help with the development of focused, culturally aware public health initiatives[7].

Ultimately, by offering a thorough examination of tobacco-related health hazards within a particularly susceptible population, the research findings are anticipated to make a substantial contribution to the body of current knowledge. The knowledge gathered could help public health policymakers develop policies that not only try to lower tobacco use but also improve the general health system serving Jharkhand's tribal tribes.

MATERIALS & METHODS:

Study Design and Setting:

To examine the effects of different types of tobacco on dental caries, oral mucosal lesions, and general oral hygiene among tribal groups in Ranchi, Jharkhand, this observational study used a mixed-methods approach. The study offered a thorough grasp of how tobacco smoking affected oral health in these areas by fusing quantitative evaluations with qualitative insights.

Ethical Considerations:

The Institutional Ethical Committee of Peoples University examined and approved the research protocol to guarantee that it adhered to ethical guidelines for studying humans. All participants gave their informed consent, guaranteeing their privacy and the voluntary nature of their involvement. The freedom to leave the study at any moment and without penalty was explained to the participants.

Participant Selection:

Participants were tribal members aged 18 years and older from selected areas in Ranchi. Inclusion criteria were residency in the area for at least one year and a balance of male and female participants to reflect the community's tobacco usage accurately. Individuals with a history of oral cancer or undergoing cancer treatment were excluded to focus on primary oral health assessments.

Sampling Technique:

A representative sample was chosen from several tribal clusters using stratified random sampling. Individuals who met the inclusion requirements from each major tribal group, which was proportionately represented, were selected. Targeting about 250 individuals, the study sought a robust sample size determined to identify meaningful variations in oral health outcomes.

A power analysis was conducted to determine the minimum number of participants required to detect meaningful differences with sufficient statistical rigor. Assuming a significance level (α) of 0.05 and a statistical power of 80% ($1-\beta = 0.80$), the required sample size wasestimated based on an anticipated effect size derived from previous literature or pilot data. The power calculation, performed using G*Power software, indicated that a minimum of 200 participants would be required to detect a moderate effect size. To account for potential dropouts, non-responses, and incomplete data, the sample size was increased to 250 participants, ensuring that the study remains adequately powered to detect statistically significant differences while maintaining robust generalizability of the findings.

Data Collection Methods:

Quantitative data were gathered through structured questionnaires administered in face-to-face interviews by trained field workers. These questionnaires collected detailed information on demographic background, tobacco usage patterns (both smoked and smokeless forms), and participants' awareness of the health risks associated with tobacco use. Focus group discussions (FGDs) and in-depth interviews were used to gather qualitative data in order

to investigate the deeper cultural, social, and economic factors that influence tobacco use. With six to eight participants apiece, FGDs were arranged by gender and age to promote candid conversation. To learn more about community norms and the efficacy of current tobacco-related health initiatives, key informant interviews were undertaken with long-term residents, community leaders, and healthcare professionals.

To ensure the reliability and validity of the structured questionnaire, content validity was assessed using the Content Validity Ratio (CVR), as proposed by Lawshe. A panel of seven subject matter experts in dentistry, public health, and behavioural sciences reviewed the questionnaire items for relevance, clarity, and cultural appropriateness. Each item was rated based on necessity, and the CVR was calculated using the formula CVR = (Ne - N/2) / (N/2), where Ne represents the number of experts endorsing the item as essential, and N is the total number of experts. Items with a CVR above the threshold value (based on the number of experts) were retained, ensuring strong content validity. Additionally, a pilot study was conducted with 30 participants to assess internal consistency using Cronbach's alpha, yielding a reliability coefficient of 0.85, indicating high reliability. Necessary modifications were made based on expert feedback and pilot responses to enhance clarity and ensure cultural appropriateness.

Oral Health Assessments:

All participants underwent comprehensive oral examinations by trained dental professionals. These exams included assessments for oral mucosal lesions, dental caries, and overall oral hygiene using the Oral Hygiene Index-Simplified (OHI-S). The findings were documented using standardised forms adapted from World Health Organisation (WHO) guidelines for oral health surveys[8]. Diagnostic criteria were meticulously defined to ensure uniformity across evaluations.

Study schedule:

The study was conducted over a period of six months, with the quantitative data collection phase spanning the first three months and the qualitative data collection phase occurring in the subsequent three months. Quantitative data was gathered through structured surveys administered to participants, while qualitative data was collected through in-depth interviews and focus group discussions. The time line was structured to allow sufficient time for data analysis and validation, ensuring a comprehensive integration of findings.

Statistical Analysis:

Statistical Package for Social Sciences version 25.0 (SPSS) was used to analyse the data. The demographic information and tobacco usage patterns were summarised using descriptive statistics. ANOVA for continuous variables and chi-square tests for categorical data were used to assess the prevalence of dental caries, oral mucosal lesions, and oral hygiene ratings among various tobacco user groups.

The qualitative data was analyzed using a thematic analysis approach, wherein the data was systematically coded and categorized into emerging themes. The coding process was conducted manually (or with the aid of software, such as NVivo/Atlas.ti) to ensure a structured and rigorous analysis. This approach enhanced transparency and reliability in identifying key patterns and insights from the data.

RESULTS:

250 members of Jharkhand's tribal communities were chosen as participants for the study; 130 of them were men (52%) and 120 were women (48%), ranging in age from 18 to 65. As seen in Table 1, 60% of individuals reported using tobacco, with 40% being smokers, 35% using smokeless tobacco, and 25% using both types.

Table 1: Demographic and Tobacco Usage Characteristics.

Characteristic Gender	Total (n=250)	%
Male	130	52
Female	120	48
Age Range (years)		
18-30	75	30
31-45	100	40
46-65	75	30
Tobacco Usage		
Smokers	100	40
Smokeless Tobacco Users	87	35
Dual Users (Smoke and Chew)	62	25
Non-users	100	40

Oral examinations used the Oral Hygiene Index-Simplified (OHI-S) to measure oral hygiene and determine the prevalence of dental caries and oral mucosal diseases. As seen in Table 2, the findings showed notable differences in oral health, which disproportionately affected tobacco users. When the prevalence rates of oral mucosal lesions were compared between groups using chi-square testing, statistically significant differences were found. Using a one-way ANOVA and a post hoc Tukey's honestly

Table 2: Prevalence of Oral Health Conditions.

Condition	Non-users	Smokers	Smokeless Tobacco Users	p-value
Oral Mucosal Lesions (%)	0.7%	3.8%	9.4%	<0.001*
Dental Caries (mean ± SD)	1.2 ± 0.8	2.3 ± 1.0	2.8 ± 1.2	<0.01*
OHI-S Score (mean± SD)	1.1 ± 0.3	2.2 ± 0.5	2.6 ± 0.6	<0.001*

*=Significant

significant difference test, the groups' differences in dental caries and OHI-S scores were examined. Both analyses supported statistically significant differences, suggesting that tobacco use negatively affects dental health.

Overall, the data conclusively demonstrates that among Jharkhand's tribal tribes, tobacco use—particularly smokeless forms—is highly correlated with increased incidence of oral mucosal lesions and worse oral hygiene. The necessity for focused oral health interventions in these communities is further highlighted by the statistically significant difference in dental caries and OHI-S scores.

DISCUSSION:

Our study's findings highlight the serious health effects of tobacco use among Jharkhand's tribal tribes, especially with regard to oral health outcomes including dental caries, oral mucosal lesions, and oral hygiene status. Because smokeless tobacco products are widely used in these areas, their strong carcinogenic potential is shown by the higher frequency of oral mucosal lesions among users as compared to smokers and non-users. This finding is in line with earlier studies that have repeatedly shown that using smokeless tobacco increases the chance of developing premalignant lesions and oral cancer[9].

The sugar content of chewing tobacco products and the disregard for oral hygiene habits among these demographic groups are the reasons for the significantly higher mean scores for dental caries and poor oral hygiene (OHI-S) among tobacco users, especially those who use smokeless tobacco. Tobacco smoking has been linked to higher dental caries and worse oral hygiene status, a relationship that has been extensively reported in the literature[10, 11]. These results imply that tobacco use contributes to a wide range of dental conditions in addition to raising the chance of malignant changes.It's interesting to note that smokers had a higher prevalence of oral mucosal lesions (4.0%) than smokeless tobacco users (10.0%), which suggests that smokeless tobacco use carries unique dangers due to direct mucosal contact. These findings are in line with research done on other rural and tribal groups that found a similar trend of increased risk linked to smokeless tobacco[12].

Additionally, our research advances our knowledge of how behavioural and cultural elements influence health outcomes and behaviours in tribal populations. Public health initiatives to lower tobacco use in these communities are made more difficult by the way tobacco use is incorporated into social and cultural norms[13,14]. Culturally aware health promotion tactics that honour tribal customs and inform people about the dangers of tobacco use are necessary to address these deeply rooted behaviours.

This study has certain limitations. The reliance on self-reported data may introduce recall bias and social desirability bias, potentially affecting the accuracy of responses. Additionally, thesample is drawn from a specific population, which may limit generalizability to broader demographics. While efforts were made to ensure questionnaire validity, cultural nuances and individual interpretations may still influence responses. Lastly, the cross-sectional study design prevents causal inferences, requiring further longitudinal research for stronger conclusions.

Furthermore, our study contributes to our understanding of how cultural and behavioural factors impact health outcomes and behaviours in tribal communities. The integration of tobacco use into social and cultural norms complicates public health efforts to reduce tobacco use in these communities. To address these deeply ingrained practices, culturally sensitive health promotion strategies that respect tribal traditions and educate individuals about the risks of tobacco use are required. Future research should focus on longitudinal studies to assess the causality and to monitor the progression of oral health deterioration over time due to various forms of tobacco use. Moreover, intervention studies are needed to evaluate the effectiveness of specific health promotion strategies tailored for tribal populations.

CONCLUSION:

The current study highlights the critical public health issue posed by tobacco consumption among tribal communities in Jharkhand. The significant correlation between tobacco use and increased

prevalence of oral mucosal lesions, dental caries, and poor oral hygiene necessitates urgent public health interventions tailored to the cultural and social contexts of these communities.

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Conflicts of Interest
There are no conflicts of interest.

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Research Article

Radiographic Study of Mental Foramen Type and Position in Bhopal Population using CBCT

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ABSTRACT:

Background: This radiographic study was aimed to evaluate the morphology and dimensionof mental foramen among Bhopal population. It also investigated the dimorphic variations of mental foramen with respect to gender, type, size and position using CBCT.

Materials & Methods: This study was conducted on 200 individuals of both the genders with the age range of 20 to 60 years who underwent CBCT imaging. The images were then examined for morphology and dimension of mental foramen.The images were evaluated by CS (Carestream) 3D imaging software by two experienced Oral Radiologist.

Results: Mental foramen was found to be large in 70.5%, while only 29.5% showed small size. In the present study 44.5% mental foramen were located in between the first and second premolars and 55.5% at the apex of second premolar's root. The distribution of foramen on the right and left sides in males between the first and second premolars: 44.2% were found on the right side and 55.8% were found on the left side. In the present study majority of the foramen were oval shaped and only 19% were of round shape. At the apex of roots of 2nd premolar, males showed 47.4% at right side and 52.6% at left side while in females, 48.1% were present at right and 51.9% were present at left side.

Conclusion: Mental foramen in each person presents particularities, the anatomic variations, increasing the risks during intervention. So, the clinician should confirm using 3D volumetric radiography during the preoperative phase to organize the patient treatment.

KEY WORDS: Digitalized volumetric tomography, anatomic variations, mental foramen.

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INTRODUCTION:

Mental foramen is an anatomical landmark located on the anterolateral surface of the body of the mandible.It marks the termination of the mandibular canal in the mandible, through which the inferior alveolar nerve and vessels pass. It forms an important anatomical landmark in the mandible.[1]A complete understanding of this structure is essential, as it emerges as a neurovascular bundle, and any direct or indirect damage during surgical procedure would lead to complications.[2]It is known that there are no absolute anatomical landmarks for reference, and the foramen cannot be clinically visualized or palpated. The mental foramen differs in size, shape and location which may be related to race, age and gender.[3]Several imaging modalities have been used to evaluate the morphology and morphometry of mental foramen and anterior loop of mental nerve. Cone beam computed tomography (CBCT) has brought about paradigm shift in diagnostic imaging and has helped overcome the limitations of two-dimensional imaging. CBCT is a volumetric imaging modality which is ideal for capturing anatomic structures with less radiation exposure (0.04 – 0.17

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mSv), is cost effective and has short acquisition time. All these considerations make CBCT a very promising imaging modality in maxillofacial diagnosis.[4] This research was designed to determine the morphology and morphometry of mental foramen using CBCT scan.

MATERIALS &METHODS:

This prospective, cross- sectional *in vivo* observational study after approval from the Institutional Ethical Committee recruited 200 patients from the outpatient Department of Oral Medicine and Radiology of People's Dental Academy, Bhopal (M.P.)

The inclusion criteria were as follows:

1. Age group of patients between 20 and 60 years
2. Patients with edentulous areas in the posterior region of the mandible.

The exclusion criteria were as follows:

1. Patients with systemic disease (rheumatoid arthritis, osteomalacia, osteogenesis imperfecta, osteoporosis)which can affect bone integrity
2. Patients suffering from bleeding disorders (hemorrhagicdia thesis, drug- induced)
3. Anticoagulation
4. Patients with pathologies in the upper and lower jaws and oral mucous membrane
5. Immunocompromised patients (HIV, immune suppressive medications)
6. Drug abusers, alcohol consumers, and heavy smokers
7. Psychological and mental disorders
8. Noncompliant patients
9. Patients who underwent radiotherapy
10. Patients with habit of bruxism
11. Patients on I.V. bisphosphonates.

METHODOLOGY:

This study initiated with clinical history, general and oral examination after attaining a written informed consent from the patients. Further, provisional diagnosis, CBCT indication and treatment advised were noted. The CBCT imaging was done for the mandible bilaterally using CBCT machine CS-9600 with exposure parameter 90kV, 10mA and voxel size 300µm scan was taken with exposure time 20 seconds. The acquired image was captured by Dimax3 Ceph digital sensor and CS 3D imaging software was used (Image1,2,3). These digital images were then carefully evaluated on CS 3D imaging software by two experienced Oral Radiologist for radiographic evaluation of mental foramen in the jaw. The location of the mental foramen were analyzed and classified under the following position.

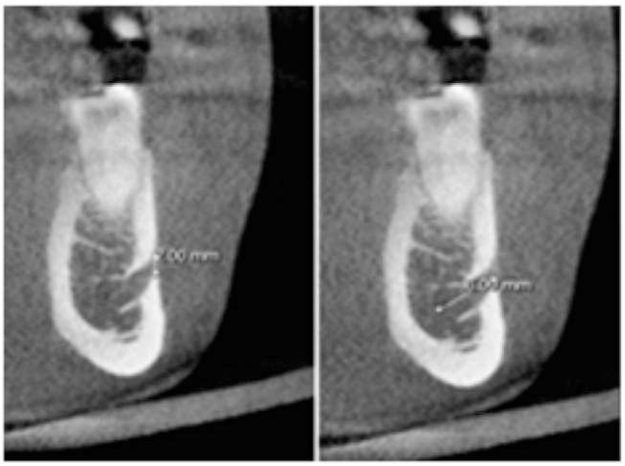

Image1: Height and length of mental foramen.

Image 2: Position of mental foramen.

Image3: Anterior loop of inferior alveolar nerve canal.

- I- between canine and first premolar;
- II- below the first premolar;
- III- between first and second premolars;
- IV- below the second premolar;
- V- between second premolar and first molar;
- VI- below the first molar.[3]

The data was tabulated and analyzed using SPSS software Version 25.0 (SPSS Inc., Chicago, IL, USA). Descriptive statistics and chi-square test were used to analyse the results and p-value of ≤0.05 was considered significant.

- I- between canine and first premolar;

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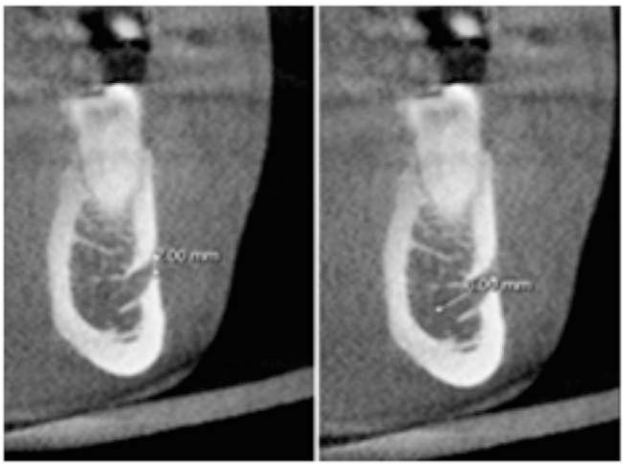

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RESULTS:

When we compare the frequency distribution of mental foramen size in the 200 patients in this study, the largest number of subjects (70.5%) exhibited large size mental foramens, while only 29.5% showed small size. Of all the males, 73% had large mental foramens and 27% had small ones, based on gender. The difference in the size of the mental foramen in 32.0% of females and 68.0% of females was not statistically significant. When the size of mental foramen was compared by side, 23.5% of large foramen and 9.5% of tiny foramen were found on the right side (Table 1, Figure 1). There were 20% small and 47% large foramens on the left side, with no discernible difference between the two sides (Table 2, Figure 2).

The frequency distribution of mental foramens according to position shows that there are 44.5% foramens between the first and second premolars and 55.5% below root apex of second premolar's apical root.The gender distribution of males and females indicates that more foramens were seen in the space between the second premolars' apical roots (57.0%, 54.0%).The difference between the first and second premolar positions was seen in 43.0% of males and 46.0% of females, although it was not statistically significant.

Table 3, Figure 3 shows the distribution of foramen on the right and left sides in males between the first and second premolars: 44.2% are found on the right side and 55.8% are found on the left side, while in females, the distribution is 43.5% on the right side and 56.5% on the left side. At apical roots of 2nd premolar, in males 47.4% present at right and 52.6% present at left side. In females 48.1% present at right and 51.9% present at left side and the difference between the groups were also not statistically significant (Table 4, Figure 4).

Table 1: Frequency distribution of mental foramen according to size and gender (n-200).

Size of metal foramen	Male n (%)	Female n (%)	Total n (%)	Chi- square value	*p*-value
Big	73(73.0%)	68 (68.0%)	141 (70.5%)	0.601	0.535
Small	27 (27.0%)	32(32.0%)	59(29.5%)		
Total	100 (100%)	100(100%)	200 (100%)		

n– Number of samples

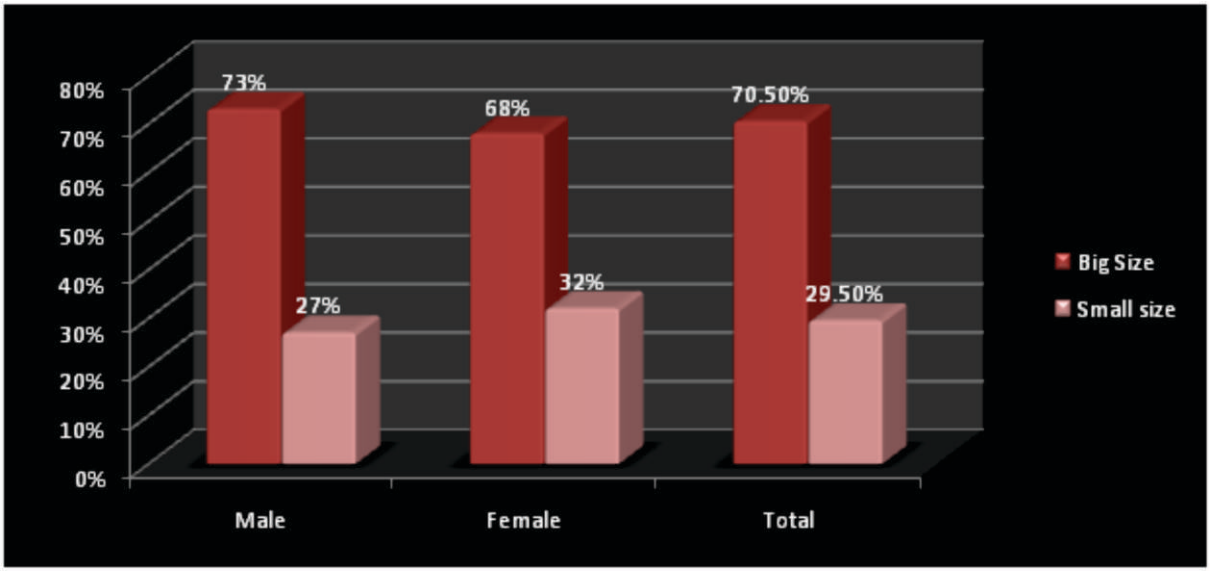

Figure 1: Frequency distribution of mental foramen according to size and gender.

Table 2: Frequency distribution of size of mental foramen according to right and left side and gender (n-200).

Side of mental foramen	size	Male n (%)	Female n (%)	Total n (%)	Chi-square value	*p*-value
Right side	Big	24 (24.0%)	23(23.0%)	47 (23.5%)	0.644	0.886
	Small	9(9.0%)	10(10%)	19 (9.5%)		
Left side	Big	49 (49.0%)	45(45.0%)	94(47.0%)		
	Small	18(18.0%)	22(22.0%)	40(20.0%)		
Total	100(100%)	100 (100%)	200 (100%)			

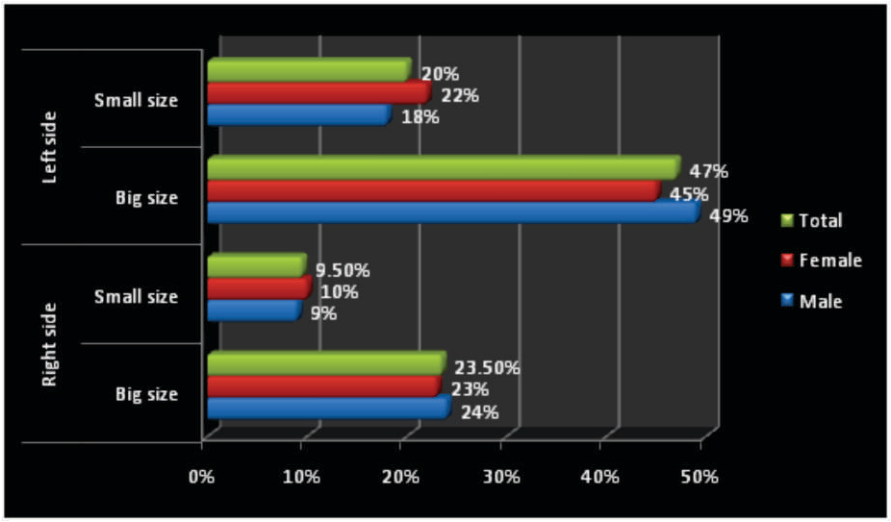

Figure 2: Frequency distribution of size of mental foramen according to right and left side and gender.

Table 3: Frequency distribution of mental foramen according to position in mandibular and gender (n-200).

Position of mental foramen	Male n (%)	Female n (%)	Total n (%)	Chi- square value	*p*-value
Between 1st and 2nd Premolar	43 (43.0%)	46 (46.0%)	89 (44.5%)	0.182	0.776
Root apex of 2nd premolar	57 (57.0%)	54 (54.0%)	111(55.5%)		
Total	100 (100%)	100(100%)	200(100%)		

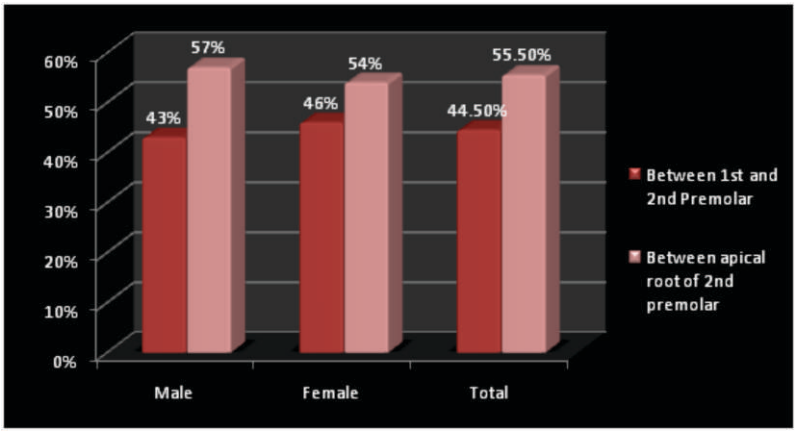

Figure 3: Frequency distribution of mental foramen according to position in mandibular and gender.

Table 4: Frequency distribution of mental foramen according to right and left position in mandibular and gender (n-200).

Gender	Side	Between 1st and 2nd Premolar n (%)	Root Apex of 2nd premolar n (%)	Total n (%)	Chi-square value	p-value
Male	Right	19 (44.2%)	27(47.4%)	46(46.0%)		
	Left	24(55.8%)	30(52.6%)	54(54.0%)		
Total		43 (43.0%)	57 (57.0%)	100 (100%)		
Female	Right	20 (43.5%)	26(48.1%)	46 (46.0%)	0.100	0.341
	Left	26 (56.5%)	28(51.9%)	54(54.0%)		
Total		46 (46.0%)	54 (54.0%)	100 (100%)		
Total		89 (44.5%)	111(55.5%)	200(100%)		

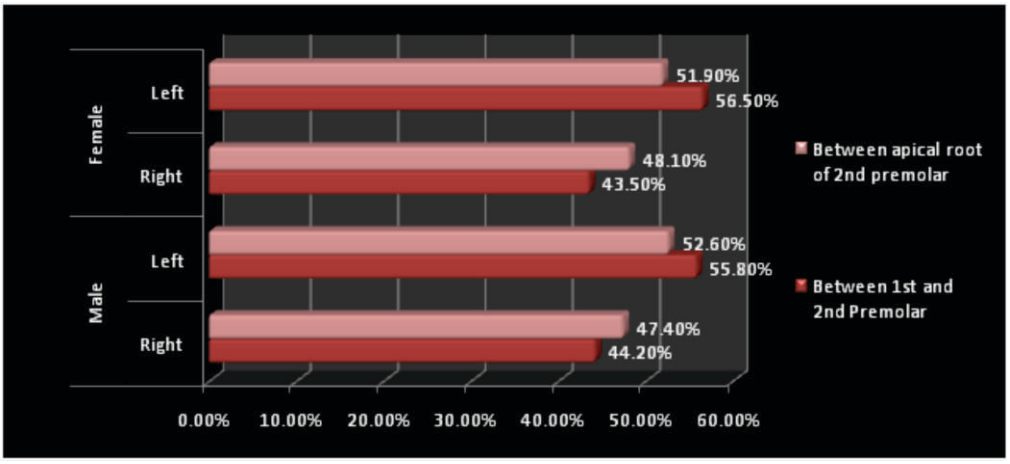

Figure 4: Frequency distribution of mental foramen according to right and left position in mandibular and gender.

Only 19% of round foramen was found, however the majority (81.0%) of oval foramen were detected based on the shape of the mental foramen at the right side. Gender-wise, 75% of men and 87% of women had oval-shaped foramens, whereas 25% of men and 13% of women had round foramens. This difference was statistically significant (p-0.031). Likewise, on the left side, there was 74% oval and just 26% round foramen. The foramen shapes of 62% of males and 86% of females were oval, whereas 38% of males and 26.9% had round shapes, and the difference was statistically significant (p-0.000) (Table 5; Figure 5).

DISCUSSION:

The mental foramen is a strategically important landmark during surgical procedures. Its location, number of foramina, and possibility of anterior loop of the mental nerve or AMF (accessory mental foramen) being present need to be considered before surgery to avoid mental nerve injury. The damage to mental foramen or inferior alveolar nerve during oral surgery or implant placement is a serious complication.[5]

Procedures such as placement of dental implants, osteotomy, bone harvesting, although considered to be safe elective procedures, sensory disturbances have been reported as a complication in upto 31% of patients in the first two weeks following surgery, with 10-15% of patients continuing to complain of sensory disturbances even up to 15 months after procedure.[6]This radiographic study was aimed to evaluate the morphology and dimensions of mental foramen and the anterior loop with an objective to assess their variations among Indian population. This study also assessed the dimorphic variations of mental foramen and its anterior loop with respect to gender and laterality using CBCT.

In the present study the largest number of subjects (70.5%) exhibited large size mental foramens, while only 29.5% showed small size. Of all the males, 73% had large mental foramens and 27% had small ones. Whereas of all 68% female has larger mental foramen and 32% mental foramen are smaller in size. R. Dos Santos Oliveira, has found similar differences in the size of mental foramen in male and female where male exhibit large size of mental formen then

Table 5: Frequency distribution of shape of mental foramen according to right and left position in mandibular and gender (n-200).

Side	Shape	Male	Female	Total	Chi- square value	p-value
Right side	Round	25 (25.0%)	13 (13.0%)	38 (19.0%)	4.678	0.031*
	Oval	75(75.0%)	87 (87.0%)	162 (81.0%)		
	Total	100 (100%	100(100%)	200(100%)		
Left side	Round	38 (38.0%)	14(14.0%)	52(26.0%)	14.969	0.000*
	Oval	62(62.0%)	86(86.0%)	148(74.0%)		
	Total	100 (100%)	100 (100%)	200(100%)		

*Statistically Significant

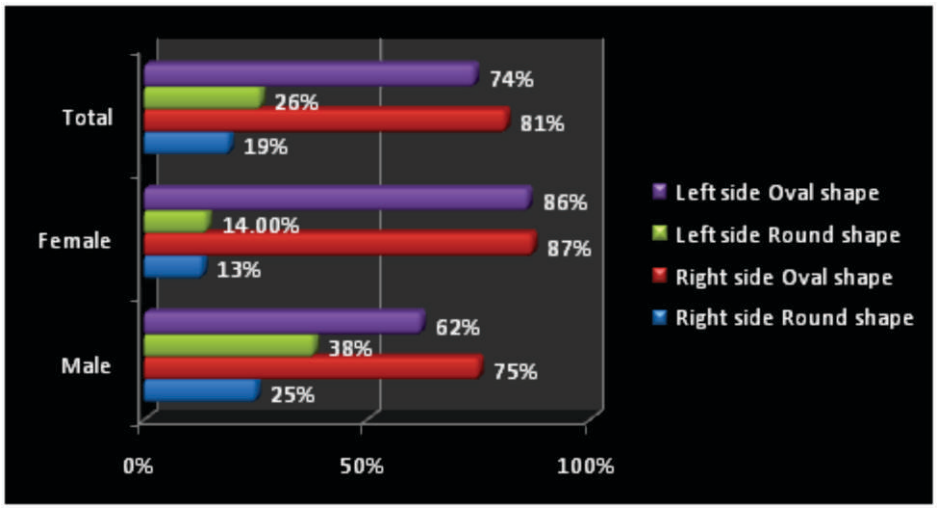

Figure 5: Frequency distribution of shape of mental foramen according to right and left position in mandibular and gender.

female.[7]The results were consistent with those found by Gungor et al. , Zhang et al., and Kalender et al. , in which the horizontal and vertical diameters evaluated also in CBCT study were higher in men in comparison to women.[8],[9],[10] In the present study when the size of mental foramen was compared by side, 23.5% of large foramen and 9.5% of tiny foramen were found on the right side. There were 20% small and 47% large foramens on the left side, with no discernible difference between the two sides.

In the present study 44.5% mental foramen were located in between the first and second premolars and 55.5% at the apex of second premolar's root. Similarly, P. Carruth et al. reported the gender distribution of male and female which indicates that more foramens were shown in the space between the second premolars' apical roots (57.0%, 54.0%).[11] Whereas in Antoinette Pele et al. study, gender and side did not seem to have influence on the mental foramen location in relation to the teeth.[12] According to Chen et al., the presence of an anterior loop of the inferior alveolar nerve (AL) could have an influence on the position of MF to the teeth. Indeed, at the majority position, without AL, the MF was found at 51.7% between PM1 and PM2, whereas when there was an AL, it was found at 73.3% apically to the PM2.[13] On the contrary, in Krishnan et al.'s study, no significant difference was noticed.[14] The results of the present study corroborated the data from Indian populations reported by Bhagat et al.[15]Alok et al.,[16]Swamy et al.,[17] and Srivastava et al.[18] which conclusively stated that the most common position of MF in the Indian population was below the mandibular second premolar, followed by the position between the 2 premolars.

In present study the distribution of foramen on the right and left sides in males between the first and second premolars: 44.2% are found on the right side and 55.8% are found on the left side, while in females, the distribution is 43.5% on the right side and 56.5% on the left side. At the apex of roots of 2nd premolar, in males 47.4% present at right and 52.6% present at left side. In females 48.1% present at right and 51.9% present at left side and the difference between the groups were also not statistically significant. Similarly Komal Sheth et al. found mental foramens were most often located at the apex of the mandibular second

premolar.[19]On both the left and right sides, both males and females predominantly showed the mental foramen in the second premolar region, followed by distal to the first premolar and medial to the second premolar. The root apex of the second premolar on both sides of the mandibular arch was closest to the mental foramen in the sagittal plane, which is in agreement with study performed by Phillips JL et al.[20] and Ngeow WC[21]

In the present study majority of the foramen was oval shaped on and only 19% were of round shape at the right side. Gender-wise, 75% of men and 87% of women had oval-shaped foramens, whereas 25% of men and 13% of women had round foramen.[19][20] The results coincided with the left side as well as maximum number of foramen were oval shaped which was 74% oval and just 26% round foramen (Table5; Figure 5) Komal Sheth et al in her study showed that on the left side, 71% (337/475) of cases had the root apex of the second premolar closest to the mental foramen, whereas on the right side, 62% (295/475) of cases had the root apex of the second premolar closest to the mental foramen, which is similar to the pattern found on the contra lateral side.[19][20] The next most frequent location of the mental foramen was between First Premolar and Second Premolar position, which was found in 14% (67/475) of cases on the left side and in 26% (124/475) of cases on the right side.

The inconsistent position of the mental foramen should always be considered while investigating radiographic periapical areas and while performing periodontal or endodontic surgery in the area between the canine and the mesial root of the first molar. Furthermore, the position of the mental foramen varies across ethnic groups,[21] which should alert the clinician to consider variability in their patient populations.

The data was subjected to intra and inter examiner variability. Statistical analysis showed there was no significant difference in the intra as well as inters examiner observations. Ludlow JB et al. Found CBCT scans to have an error of less than 0.6% while measuring mandibular anatomy.[22] This suggest that measurements made on CBCT images are accurate and reproducible. Thus, high resolution CBCT images are considered one of the most promising and precise techniques that accurately determine the mental foramenfor varied applications in dentistry.

CONCLUSION:

The morphology of the mental foramen showed variations among the gender and age in Bhopal population. Hence, treatment planning that involves the interforaminal region of the mandible should be carried out on a case-by-case basis to determine appropriate location and dimension of mental foramen. A good intra and inter examiner reliability was observed in our study, suggesting that measurements made on CBCT images are accurate and reproducible.

Financial Support and Sponsorship

Nil.

Conflicts of Interest

There are no conflicts of interest.

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Research Article

The Battle of Digital Verses Conventional Impression- A Systematic Review Analysis

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ABSTRACT:

Background- Digital impressions have revolutionized implant dentistry, offering advantages in accuracy, efficiency, and patient comfort. However, conventional impressions remain widely used, particularly in cases requiring detailed soft tissue capture and full-arch rehabilitations.

Materials & Methods- The aim of this systematic review was to compare digital and conventional impression techniques in fully and partially edentulous patients based on accuracy, patient perception, time efficiency, technique sensitivity, and operator preferences. A systematic search was conducted in PubMed, Scopus, Web of Science, and Cochrane Library following PRISMA guidelines. Eligible studies included randomized controlled trials, clinical comparative studies, and in vitro research published between 2010 and 2025. The risk of bias was assessed using the Cochrane Risk of Bias Tool for randomized controlled trialsand the Newcastle-Ottawa Scale for non-randomized studies.

Results- A total of 13 studies met the inclusion criteria. Digital impressions demonstrated comparable or superior accuracy to conventional impressions, particularly in single-implant and short-span prostheses. Studies reported that digital impressions reduced chair side time and improved workflow efficiency, with significant reductions in retake rates and errors. Patient satisfaction was notably higher with digital impressions due to reduced discomfort and gag reflex. However, full-arch digital impressions showed minor deviations and conventional impressions remained preferable in highly angulated implants and deep subgingival margin cases.

Conclusions- Digital impression techniques provide high accuracy, efficiency, and patient satisfaction, making them a reliable alternative to conventional techniquesin many clinical scenarios. However, conventional impressions remainnecessary in specific cases where digital scans may struggle with angulated implants or deep tissue capture.

KEY WORDS: Digital impressions, Conventional impressions, Intra-oral scanners, Implant dentistry, Prosthetic fit.

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INTRODUCTION:

Achieving an accurate and high-quality dental model is fundamental for the success of prosthetic and restorative treatments. The precision of an impression directly affects the clinical fit of dental prostheses, influencing treatment outcomes and patient satisfaction.[1]

Over the years, numerous impression materials and techniques have been introduced to enhance the accuracy and reproducibility of dental models. Traditional impression techniques have primarily relied on elastomeric materials such as polyvinyl siloxane (PVS) and polyether, known for their excellent detail reproduction and dimensional.[2] However, with advancements in digital dentistry, intraoral scanning

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technology has emerged as a viable alternative, offering improved efficiency, accuracy, and patient comfort.[3]

According to the 8th edition of The Glossary of Prosthodontic Terms**,** adental impressionis defined as *"a negative likeness or copy in reverse of the surface of an object; an imprint of the teeth and adjacent structures for use in dentistry"*.[4] This definition highlights the importance of obtaining a precise negative replicaof the oral cavity to fabricate an accurate working model. Any distortion or error in the impression can lead to ill-fitting prostheses, necessitating adjustments or remakes, which can increase clinical time and costs.[5]

The introduction of digital impression techniques has significantly transformed dental work flows by eliminating the material-induced distortions seen in conventional methods and allowing for immediate visualization of scan data.[6] Digital impressions offer several advantages, including enhanced patient experience, reduced chair side time, and streamlined communication with dental laboratories.[7] Moreover, the integration of computer-aided design and computer-aided manufacturing (CAD/CAM) systems has further optimized the fabrication of fixed and implant-supported restorations, improving their accuracy and longevity.[8]

The concept of a virtual patient has also played a crucial role in modern digital dentistry**,** reducing the likelihood of errors associated with traditional impression handling, minimizing patient discomfort, and significantly lowering material waste.[9] Additionally, with the increasing emphasis on infection control and sterilization protocols, particularly during the COVID-19 pandemic, digital impressions have gained preference over conventional techniques as they minimize the risk of cross-contamination.[3]

The primary objective of a dental impressionis to create an accurate model that replicates the intraoral conditions of the patient. The precision of this process is essential for ensuring the clinical fit of fixed dental prostheses and implant-supported restorations**,** particularly at theimplant-abutment interface.[10] Errors in impression-taking, whether due to material deformation, improper technique, or intraoral scanner inaccuracies, can significantly affect the final prosthetic outcome.[2] Therefore, selecting an appropriate impression technique-whether conventional or digital is critical for achieving optimal prosthetic success.[1]

This systematic review aims to comprehensively compare digital and conventional impression techniques based on multiple parameters, including accuracy, patient perception, time efficiency, technique sensitivity, and operator preferences. By analysing the existing literature, this study seeks to provide evidence-basedinsights into the advantages and limitations of each approach, ultimately assisting clinicians in selecting the most suitable technique for their practice.

Methodology:

Study design-

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to ensure a structured and transparent methodology. The review aimed to compare digital and conventional impression techniquesinfully and partially edentulous patients based on multiple parameters, including accuracy, patient perception, time efficiency, technique sensitivity, and operator preferences**.**

Search strategy-

The literature search was conducted comprehensively across several electronic databases to ensure the inclusion of all relevant studies. The primary databases used were PubMed/MEDLINE, Scopus, Web of Science, and the Cochrane Library, supplemented by additional searches in Google Scholar to capture any further pertinent articles. The search strategy was developed using both controlled vocabulary, such as MeSH terms, and free-text keywords to capture variations in terminology. Specific search terms included phrases such as "Digital impression," "intraoral scanner," "CAD/CAM impression," and "virtual dental model" to identify studies related to digital techniques, as well as "Conventional impression," "elastomeric impression," "polyvinyl siloxane," and "polyether" for conventional methods. To capture relevant outcomes and populations, additional keywords such as "accuracy," "patient satisfaction," "time efficiency," "operator preference," "edentulous patients," and "partial edentulism" were incorporated into the search string. Boolean operators (AND, OR) were used to combine these search terms systematically, thereby ensuring that studies meeting the inclusion criteria for population, intervention, comparison, and outcomes were identified. The search strategy was further refined by applying filters for publication date (from 2010 to 2025) and language

(English) to ensure relevance to contemporary practices and technological advancements. In addition, reference lists of key articles and existing systematic reviews were manually examined to identify any studies that might have been missed in the initial electronic search. This detailed approach was designed to maximize the retrieval of relevant literature while minimizing the potential for overlooking important studies.

The research question formulated was:

"In fully edentulous and partially edentulous patients, how does the digital impression technique compare with the conventional impression technique in terms of accuracy, patient perception, time efficiency, technique sensitivity, and operator preferences?"

PICO Framework:

A structured PICO (Population, Intervention, Comparison, and Outcome) framework was used to define inclusion and exclusion criteria.

- **Population (P):** Studies involving fully and partially edentulous patients undergoing dental impressions for prosthetic rehabilitation.
- **Intervention (I):** Studies evaluating digital impression techniques, including intraoral scanners (IOS), CAD/CAM workflows, and digital models.
- **Comparison (C):** Studies comparing digital impressions with conventional impression techniques, using elastomeric materials such as polyvinyl siloxane (PVS) and polyether.
- **Outcomes (O):**
  Studies that assessed at least one of the following:

✓ Accuracy of impression technique
✓ Patient perception (comfort, satisfaction, preference)
✓ Time efficiency (scanning/impression-taking duration, laboratory workflow integration)
✓ Technique sensitivity and learning curve
✓ Operator preference and ease of use

Eligibility Criteria:

Inclusion criteria-

1. Studies must involve patients who are fully edentulous or partially edentulous.
2. The research must evaluate digital impression techniques, including the use of intraoral scanners, CAD/CAM workflows, or other digital methods for capturing dental impressions.
3. Studies reporting on outcomes such as accuracy, patient satisfaction, time efficiency, technique sensitivity, or operator preferences.
4. Only English-language articles published from 2010 to 2025 were included.

Exclusion criteria-

1. Studies that focused on patients without considering edentulous or partially edentulous cases.
2. Studies that did not include a direct comparison between digital and conventional impression techniques.
3. Case reports, expert opinions, conference abstracts, and letters to the editor.
4. Non-English language studies due to translation limitations.

Study selection and validity assessment-

The study selection process involved an initial search across multiple databases, followed by duplicate removal. Two independent reviewers screened titles and abstracts to identify potentially eligible studies, after which full-text articles were assessed for inclusion. Disagreements were resolved through discussion or a third reviewer, and the process was documented using a PRISMA flow diagram. For validity assessment, the methodological quality of included studies was evaluated using appropriate tools: randomized controlled trials (RCTs) were assessed with the Cochrane Risk of Bias tool, observational studies with the Newcastle-Ottawa Scale, and in vitro studies. Two independent reviewers conducted these assessments, categorizing each study as low, moderate, or high risk of bias.

Data Synthesis and Rationale for No Meta-Analysis:

Due to considerable heterogeneity among the included studies in terms of study design, population characteristics, impression systems used, outcome measurement methods, and reporting formats, a quantitative meta-analysis was not feasible. The variation in outcome definitions and lack of uniform statistical data further limited the ability to perform a

pooled analysis. Therefore, a narrative synthesis of findings was conducted to compare digital and conventional impressions across the evaluated parameters.

RESULTS:

Study Selection- A total of 1,255 articles were identified through database searches. After removing 1,011 duplicates, 81 ineligible records (identified by automation tools), and 38 records removed for other reasons, 714 studies remained for screening. After title and abstract screening, 501 studies were excluded for irrelevance, leaving 213 full-text articles for retrieval. However, 101 reports could not be retrieved due to access restrictions or unavailability. The remaining 112 full-text articles were assessed for eligibility, of which 99 studies were excluded due to not meeting inclusion criteria. Ultimately, 13 studies were included in this systematic review. The study selection process is illustrated in the PRISMA flowchart (Figure 1).

Study Characteristics- The systematic review included 13 studies published between 2010 and 2025 that compared digital and conventional impression

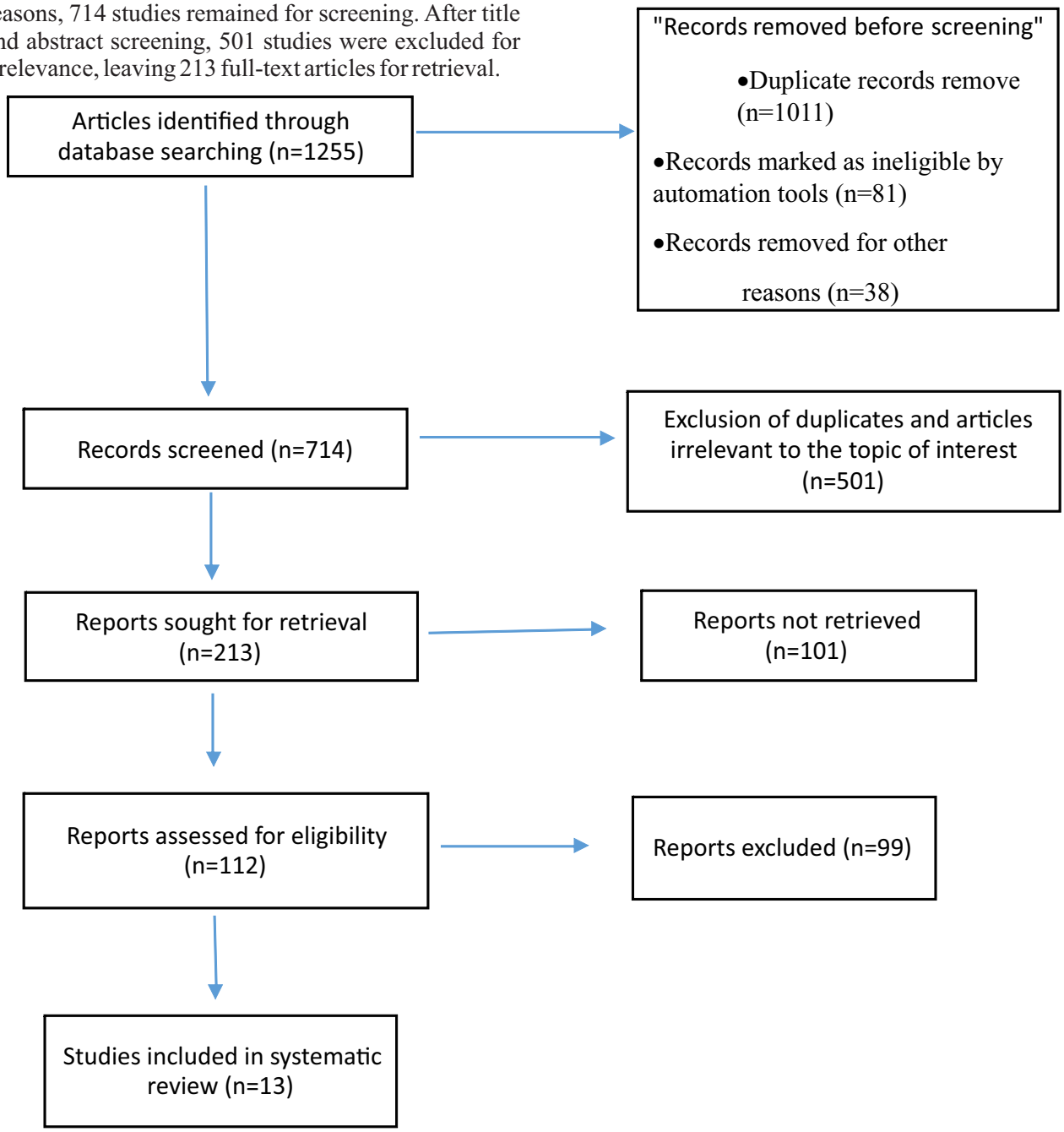
Articles identified through database searching (n=1255)
"Records removed before screening"
•Duplicate records remove (n=1011)
•Records marked as ineligible by automation tools (n=81)
•Records removed for other reasons (n=38)
Records screened (n=714)
Exclusion of duplicates and articles irrelevant to the topic of interest (n=501)
Reports sought for retrieval (n=213)
Reports not retrieved (n=101)
Reports assessed for eligibility (n=112)
Reports excluded (n=99)
Studies included in systematic review (n=13)

Figure 1: PRISMA flowchart depicting the identification, screening, eligibility assessment, and inclusion of studies in the systematic review.

Table 1: Characteristics of Included Studies.

Study	Year	Design	Arch Type	Number of Implants	Impression Technique (IL/AL)	Splint Method & Material	Impression Material	Implant Connection Type / Impression Level (IL/AL)	Angulation	Accuracy Method	Implant Brand	Type of Intraoral Scanner	Outcomes Evaluated	Key Findings
Kernen-Gintaute et al.[11]	2025	Clinical Comparative Study	Edentulous Jaws	Variable	IL	Not Specified	Not Specified	IL	Various	Linear and Angular Deviations	Not Specified	Not Specified	Accuracy of Digital vs. Conventional Impressions	Digital impressions showed comparable accuracy; minor deviations in full-arch cases.
Elashry et al.[12]	2024	Randomized Clinical Trial	Bilateral Distal Extension	Not Specified	IL	Splinted - Resin	PVS	IL	= 15-	Superimposition	Straumann	iTero	Accuracy of digital vs. conventional impressions	Digital impressions had similar accuracy to conventional impressions with reduced chairside time.
Gutmacher et al.[13]	2021	Clinical Study	Fully Edentulous Maxilla	Variable	IL	Unsplinted	Digital	IL	Various	3D Deviation Analysis	Not Specified	Not Specified	Accuracy of different digital impression systems	Digital systems were accurate, but performance varied by scanner type.
Chochlidakis et al.[14]	2020	Prospective Study	Full-Arch (Edentulous Maxilla)	16	IL	Splinted	Digital vs. Conventional	IL	Not Specified	Comparative Accuracy Study	Not Specified	Multiple Scanners	Full-arch accuracy, patient comfort	Digital impressions were faster and preferred by patients but had slight distortions in full-arch cases.
Menini et al.[15]	2018	Clinical Study	Multi-Unit Implant Impression	Variable	IL	Splinted	PVS vs. Digital	IL	= 10-	3D Accuracy Study	Not Specified	Multiple Scanners	Precision of digital and conventional impressions in multi-unit prosthetics	Digital impressions were highly accurate and reduced errors compared to conventional methods.
Marghalani et al.[16]	2018	Clinical Study	Partially Edentulous Arches	Variable	IL	Splinted	PVS vs. Digital	IL	= 10-	Accuracy Evaluation	Not Specified	Multiple Scanners	Digital vs. Conventional in partially edentulous arches	Digital techniques provided equal or better accuracy than conventional impressions.
Rech-Ortega et al.[17]	2019	In Vitro Study	Partially Edentulous	Variable	IL	Direct vs. Intraoral Scanner	Elastomeric vs. Digital	IL	Various	3D Superimposition	Not Specified	Not Specified	Digital vs. Elastomeric accuracy	Digital impressions had superior reproducibility for short-span restorations.
Amin et al.[18]	2017	Clinical Study	Full-Arch Implant	Variable	IL	Not Specified	Digital vs. Conventional	IL	Not Specified	Comparative Accuracy Study	Not Specified	Not Specified	Accuracy of digital and conventional full-arch implant impressions	Digital impressions demonstrated high precision and efficiency.

Basaki et al.[19]	2017	In Vitro Study	Not Specified	Variable	IL	Not Specified	Digital vs. Conventional	IL	Not Specified	3D Analysis	Not Specified	Not Specified	Digital vs. Conventional Accuracy in Implant Impressions	Digital scans showed minor discrepancies in long-span cases.
Yun et al.[20]	2017	Clinical Study	Fixed Prosthodontics	Variable	IL	Not Specified	Digital vs. Conventional	IL	Not Specified	Fit of Cast Gold Crowns	Not Specified	Not Specified	Comparison of fit in digital vs. conventional cast crowns	Digital impressions provided comparable fit with less distortion.
Papaspyridakos et al.[21]	2015	Clinical Study	Edentulous Patients	Variable	IL	Not Specified	Digital vs. Conventional	IL	Not Specified	Accuracy Outcomes	Not Specified	Multiple Scanners	Accuracy of digital vs. conventional impressions	Digital methods provided high precision but had challenges in full-arch cases.
Yuzbasioglu et al.[22]	2014	Clinical Study	Not Specified	Variable	IL	Not Specified	Digital vs. Conventional	IL	Not Specified	Clinical Outcomes	Not Specified	Not Specified	Patient perception, comfort, effectiveness	Digital impressions improved patient comfort and efficiency compared to conventional methods.
Lee et al.[23]	2013	Clinical Study	Single Implant	30	IL	Unsplinted	Polyether	IL	Not Specified	3D Analysis	Not Specified	Not Specified	Digital vs. Conventional in single-implant restorations	Digital impressions provided comparable accuracy but required more scanning experience.

techniques for implant-supported prostheses. The selected studies comprised RCTs, clinical comparative studies, and in vitro investigations. The number of implants assessed varied from single-unit to full-arch rehabilitations. Implant connection types included internal and external connections, assessed at both implant-level (IL) and abutment-level (AL). Impression techniques were categorized as splinted or non-splinted using materials such as PVS, vinyl polysiloxane (VPS), and polyether. Intraoral scanners like TRIOS 3, Medit i500, and CEREC Primescan were commonly used. Implant angulations ranged from 0° to 30°. Key outcomes included impression accuracy, fit, trueness, precision, patient comfort, and clinical efficiency. Most studies concluded that digital impressions demonstrated superior accuracy and efficiency, particularly in full-arch rehabilitations and cases involving angulated implants, though conventional techniques retained value in capturing soft tissue details. Brands evaluated included Straumann, Nobel Biocare, and Zimmer Biomet. Detailed characteristics are summarized in Table 1.

Risk of Bias Assessment- Risk of bias was assessed using appropriate tools. Studies like Elashry et al. (2024), Amin et al. (2017), Yun et al. (2017), and Yuzbasioglu et al. (2014) demonstrated low risk.[11,12,13,14] Others, such as Kernen-Gintaute et al. (2025), Gutmacher et al. (2021), and Basaki et al. (2017), exhibited high risk of bias due to limited blinding and unclear outcome reporting.[15,16,17] Moderate risk was observed in studies like Chochlidakis et al. (2020).[18] A summary is provided in Table 2.

Impression Accuracy- Impression accuracy was a central outcome. Digital impressions showed comparable or superior accuracy in most studies. Elashry et al. (2024) reported better trueness and precision in bilateral distal extension cases ($p < 0.05$).[11] Chochlidakis et al. (2020) confirmed clinically acceptable results for full-arch scans, though some deviations were noted.[18] In contrast, Basaki et al. (2017) noted that conventional techniques provided superior fit in highly angulated cases.[17] Gutmacher et al. (2021) found variability among scanners in cross-arch accuracy despite high reproducibility.[16]

Time Efficiency-Digital impression techniques significantly reduced chairside time and simplified clinical workflows. Gutmacher et al. (2021) and Menini et al. (2018) demonstrated faster procedures with digital

Table 2: Risk of Bias Assessment.

Study	Year	Study Design	Random Sequence Generation (Selection Bias)	Allocation Concealment (Selection Bias)	Blinding of Participants & Personnel (Performance Bias)	Blinding of Outcome Assessment (Detection Bias)	Incomplete Outcome Data (Attrition Bias)	Selective Reporting (Reporting Bias)	Overall Risk of Bias
Kernen-Gintaute et al.[11]	2025	Clinical Comparative Study	High Risk	High Risk	High Risk	High Risk	Low Risk	Low Risk	High Risk
Elashry et al.[12]	2024	RCT	Low Risk	Low Risk	Low Risk	Low Risk	Low Risk	Low Risk	Low Risk
Gutmacher et al.[13]	2021	Clinical Study	N/A	N/A	High Risk	High Risk	Low Risk	Low Risk	High Risk
Chochlidakis et al.[14]	2020	Prospective Study	Low Risk	Low Risk	High Risk	Low Risk	Low Risk	Low Risk	Moderate Risk
Menini et al.[15]	2018	Clinical Study	N/A	N/A	High Risk	Unclear Risk	Low Risk	Low Risk	High Risk
Marghalani et al.[16]	2018	Clinical Study	N/A	N/A	High Risk	Unclear Risk	Low Risk	Low Risk	High Risk
Rech-Ortega et al.[17]	2019	In Vitro Study	N/A	N/A	High Risk	High Risk	Low Risk	Low Risk	High Risk
Amin et al.[18]	2017	Clinical Study	Low Risk	Low Risk	Low Risk	Low Risk	Low Risk	Low Risk	Low Risk
Basaki et al.[19]	2017	In Vitro Study	N/A	N/A	High Risk	Unclear Risk	Low Risk	Low Risk	High Risk
Yun et al.[20]	2017	Clinical Study	Low Risk	Low Risk	Low Risk	Low Risk	Low Risk	Low Risk	Low Risk
Papaspyridakos et al.[21]	2015	Clinical Study	N/A	N/A	High Risk	High Risk	Low Risk	Low Risk	High Risk
Yuzbasioglu et al.[22]	2014	Clinical Study	Low Risk	Low Risk	Low Risk	Low Risk	Low Risk	Low Risk	Low Risk
Lee et al.[23]	2013	Clinical Study	Low Risk	Low Risk	Low Risk	Low Risk	Low Risk	Low Risk	Low Risk

- **Low Risk**: Study used proper methods, minimal bias. • **High Risk**: Flawed methodology, potential for bias.
- **Unclear Risk**: Insufficient information available.**N/A**: Not applicable for non-RCT studies.

impressions ($p<0.001$).[16,19] Lee et al. (2013) emphasized the advantage of real-time evaluation and reduced lab dependency.[20] Marghalani et al. (2018) found fewer retakes with digital methods.[21]

Patient Comfort and Preference-Studies unanimously showed greater patient satisfaction with digital impressions. Yuzbasioglu et al. (2014) and Marghalani et al. (2018) reported reduced discomfort and fewer gag reflexes.[14,21] Papaspyridakos et al. (2015) highlighted the non-invasive nature and shorter duration of digital impressions as key factors for edentulous patients.[22]

Prosthetic Outcomes and Clinical Performance Prosthetic outcomes such as implant survival and marginal fit showed no significant differences between techniques. Amin et al. (2017) and Papaspyridakos et al. (2015) observed comparable survival rates and prosthetic fits.[12,22] Elashry et al. (2024) and Kernen-Gintaute et al. (2025) emphasized the importance of implant angulation and soft tissue management, with conventional impressions occasionally preferred in complex cases.[11,15]

Digital impressions demonstrated significant advantages in accuracy, efficiency, and patient

satisfaction. However, conventional techniques remain clinically relevant for capturing detailed soft tissue in complex cases. The decision between digital and conventional methods should be guided by case complexity, available technology, and clinician experience.

DISCUSSION:

The evolution from conventional to digital impression techniques marks a significant advancement in prosthodontics, reshaping clinical workflows and patient experiences. This systematic review offers a comprehensive comparison of these two approaches across parameters including impression accuracy, time efficiency, patient comfort, and prosthetic outcomes—particularly in the context of implant-supported restorations.

Key Differences Between Digital and Conventional Techniques:

Digital impressions, captured using intraoral scanners, eliminate the need for impression trays and materials, thereby reducing the likelihood of distortion, improving patient comfort, and enabling real-time verification. In contrast, conventional impressions using materials like PVS or polyether require more clinical steps, including setting, tray removal, disinfection, and laboratory pouring, which introduces opportunities for dimensional inaccuracies. While digital systems offer superior time efficiency and reproducibility-especially in single-unit and short-span restorations-certain limitations persist in full-arch or highly angulated implant scenarios, as highlighted in studies.[16,17]

The review shows that digital impressions generally yield comparable or superior accuracy to conventional methods, particularly in bilateral distal extension and straight implant cases.[11,18] However, in highly complex cases involving soft tissue undercuts or steep implant angulations, conventional impressions may provide better adaptability and detail capture.[15]

Clinical Efficiency and Patient-Centered Outcomes-
Digital workflows consistently demonstrated a reduction in chairside time and minimized the need for impression remakes, as shown in studies by Menini et al. (2018) and Marghalani et al. (2018).[19,21] This time-saving aspect, coupled with improved patient comfort due to the absence of bulky trays and impression materials, contributes to increased patient satisfaction—particularly for edentulous individuals and those with a strong gag reflex (Yuzbasioglu et al., 2014; Papaspyridakos et al., 2015).[14,22]

Prosthetic Success and Clinical Outcomes:

Despite differences in technique, prosthetic outcomes such as marginal fit and implant survival rates were largely equivalent between digital and conventional impressions. Amin et al. (2017) and Papaspyridakos et al. (2015) both reported no significant clinical difference in long-term prosthetic success, supporting the reliability of both techniques when applied appropriately.[12,22] However, digital impressions may require more operator training and equipment investment, factors that can influence clinical decision-making.

Novelty and Contribution of This Review:

This review is distinct in its targeted focus on implant-supported prostheses in edentulous and partially edentulous patients, integrating evidence from the most recent studies (up to 2025) and evaluating performance across varying implant angulations and arch configurations. Unlike earlier reviews that primarily focused on single crowns or fixed dental prostheses, this study bridges a crucial knowledge gap by addressing full-arch accuracy, soft tissue challenges, and complex prosthetic demands—areas where digital impressions still face limitations.

Furthermore, the inclusion of newer intraoral scanning systems and recent clinical trials reflects advancements in scanning technology and CAD/CAM integration, providing a more current clinical perspective. This makes the review particularly valuable for prosthodontists navigating the transition to digital workflows.

Clinical Implications:

The findings reinforce the importance of individualized treatment planning. While digital impressions offer advantages in terms of efficiency and patient experience, conventional techniques remain indispensable in cases requiring precise soft tissue management or where scanner access is limited. As technology continues to evolve—particularly with the integration of AI-based error correction and improved image stitching—the scope of digital impressions is expected to broaden. However, clinical judgment should remain at the core of technique selection.

Strength-The strengths of this study lie in itsrigorous methodology**,** adherence toPRISMA guidelines**,** and inclusion ofRCTs, clinical studies, and in vitro research**,** ensuring acomprehensive evidence base**.** Adetailed risk of bias assessmentenhances the credibility of the findings. The study evaluatesmultiple

key outcomes, includingaccuracy, efficiency, patient satisfaction, and prosthetic fit, making it highlyclinically relevant. By comparing findings with previoussystematic reviews and meta-analyses, it strengthens scientific consensus. Additionally, it identifiesgaps in research, particularly infull-arch and highly angulated implant cases, encouraging further advancements indigital impression technology.

***Limitations*-** This systematic review has some limitations. The included studies had variations in study designs, sample sizes, and evaluation parameters, which may introduce bias. Additionally, the rapid technological advancements in digital impression systems mean that newer studies may present improved accuracy compared to the currently available data. Further randomized controlled trials with standardized methodologies are needed to validate the findings.

CONCLUSION:

This systematic review demonstrates that digital impression techniques offer considerable benefits over conventional methods in terms of accuracy, time efficiency, and patient comfort, particularly in straightforward implant-supported prosthetic cases. However, conventional impressions remain a vital option in scenarios involving complex anatomy, severe implant angulation, or the need for detailed soft-tissue capture. Given the findings, clinicians are encouraged to adopt digital impressions when dealing with single-unit or moderately spaced implant restorations, as they can enhance workflow efficiency and patient experience. For complex full-arch rehabilitations and cases with challenging anatomical constraints, a careful evaluation should be made before choosing between digital and conventional methods.

RECOMMENDATION:

- **Digital impression techniques** should be preferred for single-unit to short-span implant restorations, especially in cases with parallel implant placement and good access, due to their advantages in efficiency, accuracy, and patient comfort.
- **Conventional impressions** remain clinically relevant in complex rehabilitations involving steep implant angulations, inadequate scanner access, or cases requiring detailed soft tissue capture, where digital systems may face limitations.
- **Clinicians should assess each case individually**, considering available technology, operator experience, and case complexity before selecting the appropriate impression technique.
- **Future research should aim to standardize protocols, evaluate long-term prosthetic outcomes**, and incorporate cost-effectiveness analyses to support evidence-based clinical decisions.

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Conflicts of Interest

There are no conflicts of interest.

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Research Article

Perception of dentistry Among First Year Students from Medical , Paramedical and Dental Profession

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ABSTRACT:

Background- Understanding the perception of dentistry among medical, paramedical, and dental students is crucial for fostering interdisciplinary respect, improving collaboration, and addressing prevailing misconceptions about the field. This study aims to assess and compare the knowledge, attitudes, and perceptions of dentistry among first-year students enrolled in medical, dental, nursing, and pharmacy programs.

Materials & Methods-

A cross-sectional survey was conducted among first-year students from medical, dental, nursing, and pharmacy programs. A structured questionnaire containing 16 questions was distributed to evaluate students' knowledge of dentistry, their perceptions of its importance within the healthcare system, and their attitude toward pursuing dental careers or collaborating with dental professionals. The collected data was analyzed to identify significant differences in perceptions among the various academic disciplines.

Results-

Preliminary findings revealed that dental students had a significantly greater understanding of the scope and relevance of dentistry compared to their peers in medical and paramedical fields. Many medical, nursing, and pharmacy students were found to underestimate the complexity and critical role of dentistry within the broader context of healthcare. Common misconceptions included viewing dentistry as less vital profession than other healthcare professions. However, interprofessional exposure positively influenced perceptions across all groups.

Conclusions-

The study highlights the importance of increasing awareness and understanding of dentistry among non-dental healthcare students. Implementing interprofessional educational initiatives can help bridge existing knowledge gaps, correct misconceptions, and foster a more collaborative and integrated approach to patient care. Strengthening interdisciplinary connections will ultimately benefit both healthcare education and the quality of comprehensive patient management.

KEY WORDS: Interprofessional collaboration, health care profession, dental profession, oral health

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INTRODUCTION:

Oral health is considered to be a mirror of systemic health and vice-versa.[1] Dentistry, as a specialized field of healthcare, plays a pivotal role in maintaining not only oral health but also the overall well-being of individuals. However, its significance is often undervalued by professionals from other medical and paramedical disciplines. Misconceptions about dentistry's scope, its connection to systemic health, and

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the complexity of its procedures often lead to a lack of understanding and underestimation of the profession.[2] These perceptions can result in barriers to effective interprofessional collaboration, limiting the holistic approach necessary for patient-centered care.[3] Dental health is an integral component of overall healthcare that requires greater emphasis across all healthcare professions.[4] Enhancing the understanding of oral-systemic health links through interprofessional education and collaborative practices can improve patient outcomes and foster a more holistic approach to healthcare. Policymakers and educators must prioritize the inclusion of dental health training in medical, nursing, and pharmacy curricula to equip professionals with the knowledge and skills needed to address oral health effectively.[5] Dental health plays a critical role in overall health and well-being, with mounting evidence linking oral health to systemic conditions such as cardiovascular disease, diabetes, and respiratory infections.[6] However, the importance of dental health is often overlooked by healthcare professionals outside the field of dentistry, leading to missed opportunities for holistic patient care. This study aims to highlight the significance of dental health, its integration with systemic health, and the role healthcare professionals play in promoting and addressing oral health in their respective fields. Although oral health is considered a key indicator of overall health, dentistry is still neglected in medical education at the university level.[7]

MATERIALS &METHODS:

The study employed a cross-sectional survey design for 233 participants consisting of 16 questions to assess their knowledge about oral health, oral health practices, management of oral health diseases and oral health education targeting first-year students from four healthcare disciplines: medicine, dentistry, nursing, and pharmacy. Participants were recruited from a single institution to ensure consistency in academic exposure and curriculum structure. A structured and validated questionnaire was used to collect data on students' perceptions of dentistry Figure 1. The questionnaire covered key aspects such as the scope of dental practice, its relevance to systemic health, the role of dentists in multidisciplinary care, and attitudes toward pursuing or collaborating with dental professionals. The study had institutional ethical clearance.

Data collection was conducted anonymously to encourage honest responses. Descriptive statistics and inferential tests, were performed to identify significant differences in perceptions across the groups. Additionally, subgroup analysis was conducted to examine the impact of demographic factors, such as prior exposure to dental care or interprofessional education programs, on student's perceptions. Informed consent was obtained from all participants. examine the impact of demographic factors, such as prior exposure to dental care or interprofessional education programs, on student's perceptions. Informed consent was obtained from all participants.

RESULTS:

A total of 233 first-year students from dental, medical, nursing, and pharmacy programs participated in the study. Out of these, 56% were male and 44% female, and 13% having no prior exposure to health-related education. Analysis of the questionnaire responses revealed that dental students possessed significantly higher awareness of the scope and importance of dentistry compared to their medical and paramedical counterparts. They demonstrated better understanding of oral-systemic health relationships, such as the connection between oral hygiene and systemic conditions like cardiovascular diseases and diabetes. Conversely, a large proportion of medical, nursing, and pharmacy students held misconception about dentistry being primarily focused on teeth or aesthetics, and less critical than other healthcare professions. 73.40% of participants believed that, dental professionals are important members of the healthcare workforce and inter-professional collaboration between dentists and other healthcare professionals is essential for providing comprehensive patient care. 69.10% participants felt that toothache is the most common dental emergency followed by broken/fractured teeth (13.70%), oral infection (12.90%). 81% were of the opinion that dental field is equally complex compared with medical field. Regarding perception of dentistry limited to treating teeth only, 45.9% believed that it covers wide range of healthcare, while 36.8% were of the opinion that the dental field primarily focusses on teeth. Surprisingly, 50.20% participants said that understanding of the importance of oral health is poor in the community. 41.4% participants felt that dentistry is moderately recognized in healthcare industry while 26.70% felt dentistry was undervalued. 45.9% felt regular visit to a dentist is necessary while 40.7% confirmed that they visited a dentist only when they experienced some pain or discomfort.

Awareness about the recommended frequency of dental visits, emergency dental care, and the broader preventive role of dentists was also limited among non-dental students. However, majority of all respondents (86.9%) acknowledged the importance of oral health in

Figure 1: A structured and validated questionnaire was used to collect data on students' perceptions of dentistry

1. What is your course of study?
a) Medicine b) Dentistry c) Nursing d) Pharmacy

2. What is you gender?
a) Male b) Female c) Other

3. Do you believe dental professionals are important members of the healthcare workforce?
a) Strongly agree b) Agree c) Disagree

4. Do you believe that inter-professional collaboration between dentists and other healthcare professionals is essential for provide comprehensive patient care?
a) Agree b) Neutral c) Disagree

5. What is the most common dental emergency?
a) Toothache b) Swollen gums c) Broken or fractured tooth d) Oral infection

6. How do you perceive the complexity of dental procedures compared to other medical fields??
a) Equally complex b) Less complex c) Not Aware

7. Do you think dentistry is limited to treating teeth only?
a) Yes, entirely b) No, it covers a wide range of healthcare c) Primarily focused on teeth but has other roles d) Not sure

8. In you opinion. How well do people in your community understand the importance of oral health?
a) Very well b) Moderately well c) Poorly

9. Do you think dentistry is adequately recognized in the healthcare industry?
a) Yes, it is highly recognized b) It is moderately recognized c) It is undervalued compared to other fields, d) Not sure

10. Which of the following best describes your attitude toward visiting a dentist?
a) I visit regulatory for preventive care b) I visit only when I experience pain or discomfort c) I avoid visiting a dentist unless absolutely necessary
d) I have never visited a dentist

11. Do you believe that improving oral health education can reduce systemic disease?
a) Agree b) Neutral c) Disagree

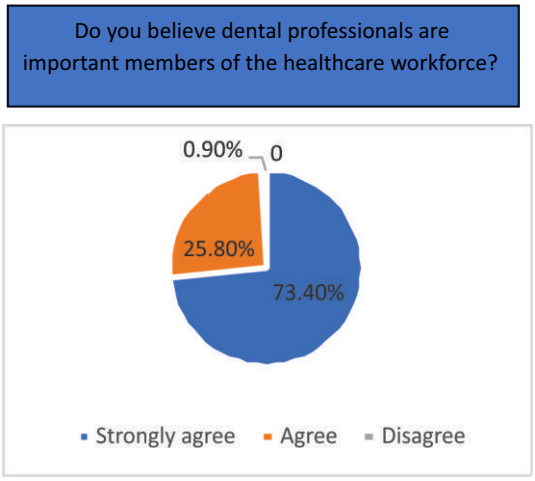
12. Should oral health awareness programs be integrated into school curriculums?
a) Yes, it is essential for early education b) No, it is not necessary c) No sure

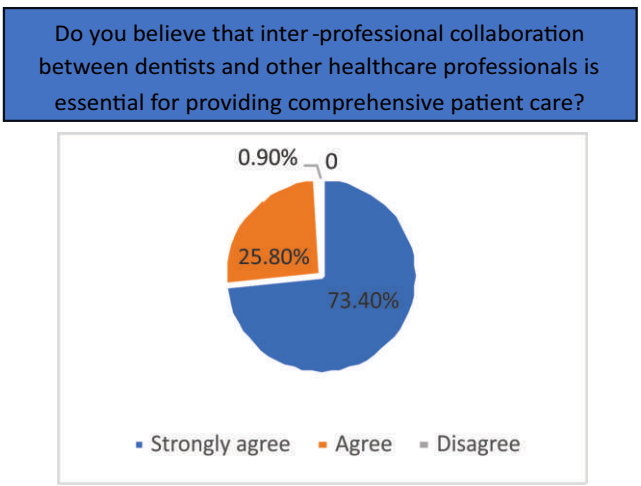
13. Which of the following diseases can poor oral health contribute to?
a) Heart disease b) Diabetes c) Respiratory infections d) All of the above

14. What is the recommended frequency of visiting a dentist for a routine check-up?
a) Every 3 months b) Every 3 months c) Once a year d) Only when there is an issue

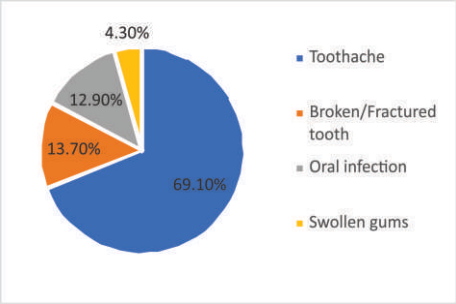
15. What do you think is the biggest misconception about dentistry?
a) Dentistry is only about teeth b) Dental procedures are always painful c) Dentistry is less important than other medical fields
d) I am unaware of misconceptions

16. What do you think is the greatest challenge in improving oral health in under served communities?
a) Lack of awareness about oral health b) High cost of dental care c) Fear of dental procedures d) Lack of government support and policies

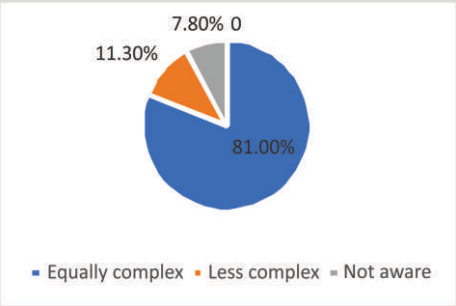




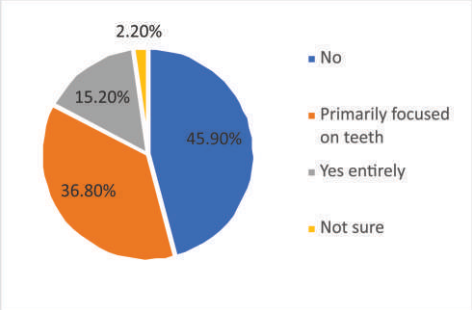
What is the most common dental emergency?



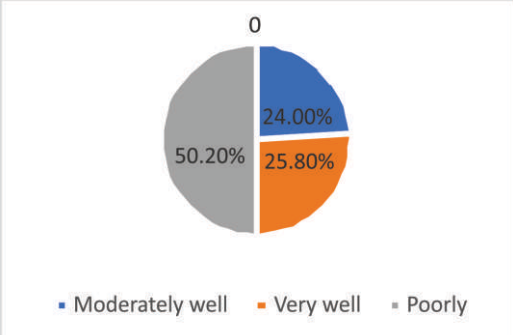
How do you perceive the complexity of dental procedures compared to other medical fields?



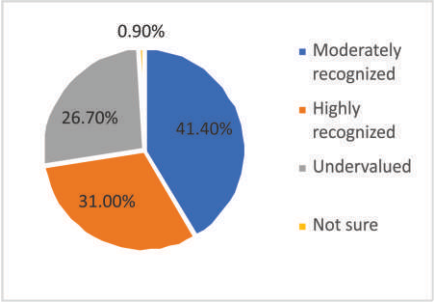
Do you think dentistry is limited to treating teeth only?



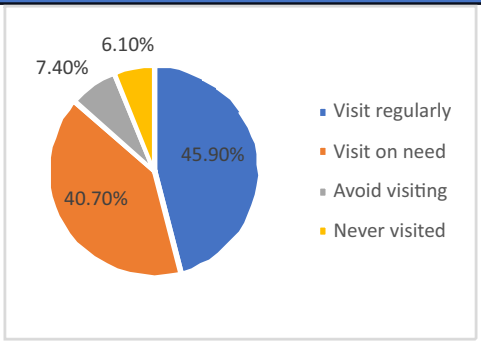
How well do people in your community understand the importance of oral health?



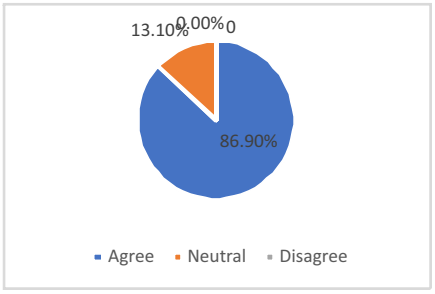
Do you think dentistry is adequately recognized in the healthcare industry?



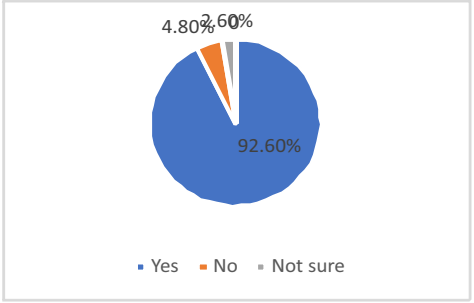
Which of the following best describes your attitude toward visiting a dentist?



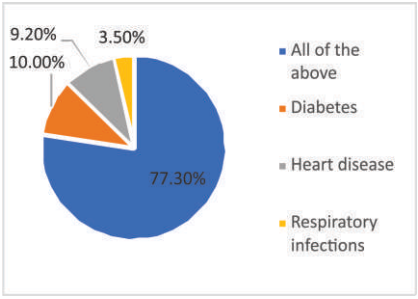
Do you believe that improving oral health education can reduce systemic diseases?



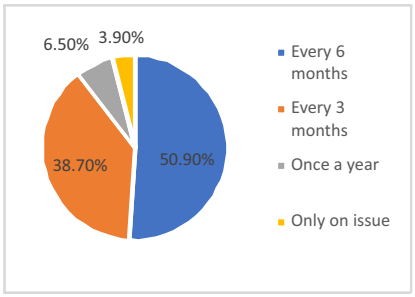
Should oral health awareness programs be integrated into school curriculums?



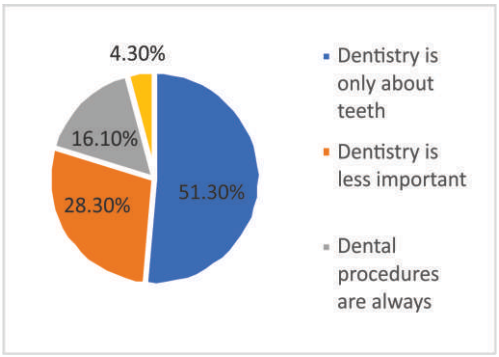
Which of the following diseases can poor oral health contribute to?



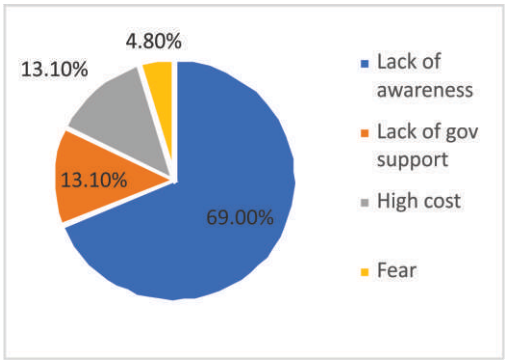
What is the recommended frequency of visiting a dentist for a routine ch eck-up?



What do you think is the biggest misconception about dentistry?



What do you think is the greatest challenge in improving oral health in underserved communities?



overall well-being and (92.6%) expressed support for greater integration of dental knowledge into school curriculum. It was found that heart diseases, diabetes and respiratory infections can contribute to poor oral health. Nearly half the respondents felt that dental visit in every 6 months is adequate while 38.70% felt it should be once a year. 51.30% participants felt that the biggest misconception regarding dentistry is that it is only related to teeth, 28.30% felt that dentistry is considered less important than medical field and 16.10% felt that dental treatments are usually painful. 69% participants felt that lack of awareness about oral health remains greatest challenge in improving oral health in underserved communities followed by lack of government support (13.1%) and cost factor (13.1%). Fear was considered to be negligible. Furthermore, students with prior exposure to interprofessional education or interaction with dental professionals tended to hold more accurate and positive perceptions of the field.

DISCUSSION:

The results of this study revealed a significant variation in the perception of dentistry among first-year students from medical, dental, nursing, and pharmacy disciplines. As expected, dental students exhibited the highest level of understanding regarding the scope, significance, and complexity of dentistry. In contrast, students from medical and paramedical fields often underestimated the role of dentistry in comprehensive healthcare, viewing it primarily as a profession focused on aesthetic treatments and dental extractions. These findings reinforce the long-standing concern that dentistry is perceived as a secondary healthcare discipline rather than an integral component of overall health.

The findings indicate that most participants acknowledge the pivotal role of dental professionals within the broader healthcare workforce. Furthermore, there was a strong consensus on the necessity of interprofessional collaboration between dental and other healthcare providers to ensure the delivery of comprehensive and holistic patient care. The present study underscores that the majority of participants recognize dental professionals as integral members of the healthcare workforce, emphasizing the necessity of interprofessional collaboration (IPC) between dental and other healthcare providers to ensure comprehensive patient care. This aligns with findings

from previous studies that highlight the value of IPC in enhancing patient outcomes and healthcare delivery. However, a cross-sectional study in Saudi Arabia assessed healthcare students' knowledge and attitudes towards interprofessional education (IPE). The findings revealed that pharmacy students had significantly more positive attitudes towards IPE compared to medical students ($p < 0.001$), while dental students' attitudes did not differ significantly from the medical student reference group ($p = 0.664$). Additionally, pharmacy and nursing students demonstrated higher knowledge scores regarding IPE than dental students.[8]

A prevalent misconception among non-dental students is the belief that dentistry is solely concerned with treating teeth, neglecting its broader roles in disease prevention, diagnosis, rehabilitation, and its integral connection to systemic health. This limited perception likely stems from insufficient exposure to oral health education within medical and paramedical curricula, a gap that can impede effective interprofessional collaboration. A study assessing medical interns' awareness in rural areas found that many lacked substantial knowledge in oral health, despite being primary health providers in these regions. This underscores the necessity of incorporating comprehensive oral health education into medical training programs. In contrast, dental students typically receive extensive training in the relationship between oral and systemic health. A study surveying dental students before and after clinical training demonstrated a significant increase in their understanding of the clinical significance of dental treatment for systemic health, highlighting the effectiveness of clinical education in enhancing this awareness. [9,10]

While medical students receive extensive training on systemic diseases, the role of oral health in these conditions is often overlooked. This study supports previous research indicating that medical and nursing students frequently have a lower awareness of the oral-systemic health connection, which can lead to missed opportunities for early detection and intervention in systemic conditions linked to poor oral health.[11]

Furthermore, the study revealed that a considerable proportion of participants from medical, nursing, and pharmacy backgrounds lacked awareness regarding the complexity of dental procedures. Although some acknowledged the importance of dentistry within the healthcare system, they appeared to underestimate the technical proficiency, specialized knowledge, and advanced procedures involved in contemporary dental practice. This limited understanding may perpetuate the misconception that dental education is less rigorous than medical education, thereby reinforcing hierarchical distinctions among healthcare professions and potentially impeding effective interprofessional collaboration. A cross-sectional study in Peshawar, Pakistan, assessed dental myths and misconceptions among medical and dental students. The study found that medical students held more misconceptions about oral health compared to dental students, indicating a gap in understanding the scope and complexity of dental care.[12]

Despite the knowledge gaps identified in this study, a positive finding was that a majority of participants, including medical and nursing students, recognized the necessity of IPC between dentists and other healthcare professionals. Respondents largely agreed that collaborative efforts between medical and dental practitioners could improve patient outcomes by addressing oral health as part of a comprehensive healthcare approach. Our results were in concordance to few other studies.[8,9] However, despite this acknowledgment, few students reported having had direct exposure to interdisciplinary training programs that integrate dentistry with other healthcare fields.

IPE has been widely promoted as a means of improving communication and cooperation among healthcare professionals.[13,14] Studies have demonstrated that early exposure to interdisciplinary learning significantly enhances students' understanding of each other's roles, reducing professional silos and improving teamwork in clinical settings.[15] The results of this study reinforce the need for structured IPE programs that incorporate dental education into medical, nursing, and pharmacy curricula. Potential strategies for achieving this include joint lectures, case discussions, and collaborative clinical rotations that emphasize the interconnectedness of oral and systemic health.

A critical insight from this study is the broader impact of limited oral health awareness on overall patient care. In many cases—especially in underserved communities—the physician's office serves as the first point of contact for patients due to limited access to dental services. When medical professionals are not adequately trained to recognize the early signs of oral disease or to understand its systemic implications, key opportunities for early diagnosis and intervention may be lost. This concern is particularly salient for conditions such as diabetes mellitus, cardiovascular disease, and respiratory infections, which have well-documented associations with poor oral health. These findings underscore the need to enhance oral health literacy among non-dental healthcare professionals to improve interdisciplinary care and patient outcomes.

The association between oral and systemic health is well-documented. Periodontal disease, for instance, has been linked to systemic conditions such as diabetes and cardiovascular disease. A study utilizing data from the National Health and Nutrition Examination Survey (NHANES) found statistically significant associations between periodontal disease and diabetes, as well as between dental caries and hypertension, underscoring the interconnected nature of oral and systemic health.[16]

The disparities in oral healthcare access between urban and rural populations were also noted in this study. Rural areas often suffer from a shortage of dental professionals, making it even more critical for medical practitioners to be equipped with basic oral health knowledge.[17] Strengthening collaboration between physicians, nurses, pharmacists, and dentists can reduce barriers to care, improve patient outcomes, and lower treatment costs by addressing oral health issues before they escalate into more severe conditions. The ongoing debate about merging certain aspects of medical and dental education was also relevant to this study's findings. While a complete integration of the two disciplines may not be feasible or widely accepted, there is increasing recognition of the need for shared learning experiences. Some universities have begun incorporating dental health topics into medical school curricula, and vice versa, to foster a more holistic understanding of healthcare. However, broader implementation of such initiatives requires institutional support, curriculum revisions, and faculty training in interprofessional education methodologies. One of the key takea ways from this study is to remember that as oral health is as important as general health, students themselves should emphasize on its important and be actively involved in shaping interprofessional education initiatives. Surveying students about their knowledge gaps, experiences, and perceptions can provide valuable insights into how educational programs should be designed. A student-driven approach to interdisciplinary education may also lead to greater acceptance and engagement, as students are more likely to value and retain knowledge that they perceive as directly relevant to their future careers.

CONCLUSION:

This study underscores the need for greater awareness and education regarding dentistry among medical, nursing, and pharmacy students. The observed knowledge gaps and misconceptions highlight the importance of integrating oral health into broader healthcare education. By fostering interprofessional education and collaboration, healthcare institutions can bridge disciplinary divides, enhance patient-centered care, and improve overall health outcomes. Strengthening the understanding of dentistry's role in systemic health will ultimately contribute to a more integrated and effective healthcare system.

Financial Support and Sponsorship
Nil.

Conflicts of Interest
There are no conflicts of interest.

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Review Article

A Review of Occlusal Considerations in Different Treatment Modalities for Implant-Supported Full-Mouth Rehabilitations

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ABSTRACT:

Occlusal considerations are crucial for the success of implant-supported full-mouth rehabilitation in completely edentulous patients, ensuring proper force distribution, preventing implant overload, and enhancing prosthetic stability. Different treatment modalities, such as implant-supported overdentures, fixed prostheses, All-on-4, and All-on-6 systems, require distinct occlusal approaches. Implant-supported overdentures depend on balanced force distribution across implants and the residual ridge, utilizing occlusal schemes like balanced occlusion, group function, and mutually protected occlusion. Minimizing lateral stress on posterior implants and ensuring anterior guidance with posterior disocclusion is essential for implant longevity. For implant-supported fixed prostheses, axial loading helps reduce lateral stress and maintain stability, while a non-interfering occlusion prevents overloading. Canine guidance or group function ensures even force distribution, protecting posterior implants from excessive lateral forces. The All-on-4 and All-on-6 systems require occlusal designs that minimize lateral forces, with anterior guidance allowing posterior disocclusion and group function distributing laterotrusive forces to protect the canines. The All-on-6 system, with additional implants, improves stability and load distribution. Across all implant-supported systems, proper planning of implant positioning, occlusal design, and prosthetic materials is vital for long-term success. A well-balanced occlusion enhances function, prevents complications, and improves patient satisfaction, ensuring the longevity of implant-supported rehabilitations.

KEY WORDS: Overdentures, Impant supported, fixed prostheses, balanced occlusion

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INTRODUCTION:

The concept of full mouth rehabilitation for completely edentulous patients has indeed evolved significantly over the years. This evolution has been primarily driven by advancements in dental technology, materials, and treatment modalities, allowing for more effective, functional, and aesthetically pleasing solutions[1]. In the case of full mouth rehabilitation, dental implants have indeed marked a major advancement in modern dentistry. They provide a comprehensive solution for restoring oral function, aesthetics, and overall quality of life, particularly for completely edentulous patients. Implants are a versatile and reliable choice for replacing missing teeth, offering several treatment modalities tailored to different patient needs and preferences.

Implant-supported prostheses significantly improve function, comfort, and patient satisfaction compared to traditional dentures. However, their

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unique biomechanical characteristics require careful occlusal design to prevent complications such as excessive stress on implants, prosthetic fractures, or peri-implant bone loss.[2]

Many occlusal concepts originate from natural dentition and are adapted for implant-supported prostheses (ISP) with necessary modifications due to fundamental differences between teeth and implants. Unlike natural teeth, implants lack a periodontal ligament, reducing proprioception and shock absorption. This means that traditional occlusal schemes must be adjusted to accommodate these biomechanical differences.[1] Despite the vast knowledge on occlusion in natural dentition, a comprehensive, evidence-based review focusing specifically on occlusion in implant-supported full-mouth rehabilitations is lacking. Given the biomechanical differences between natural teeth and implants, it's crucial to compile and analyze existing occlusal concepts, modifications, and clinical recommendations to provide a standardized approach for long-term success.

TREATMENT MODALITIES IN COMPLETELY EDENTULOUS PATIENTS:

Selection of appropriate occlusal scheme is important. Biomechanically controlled occlusion is a crucial factor in ensuring the clinical success and longevity of implant-supported prostheses. Since implants lack the adaptive capacity of the periodontal ligament, they are more susceptible to occlusal overload, which can lead to complications such as prosthetic fractures, screw loosening, marginal bone loss, and even implant failure. The occlusal design in implant-supported prostheses must be based on sound mechanical principles to ensure both mechanical integrity and biological stability. Since implants lack the cushioning effect of the periodontal ligament, excessive occlusal forces can directly translate into bone stress, potentially leading to marginal bone loss, implant overload, or prosthetic complications.

1. OCCLUSION IN IMPLANT SUPPORTED OVER DENTURES:

Implant supported overdentures (ISODs) must follow the RP-5 classification, meaning they rely on both implant and posterior soft tissue support. This design ensures a balance between stability and stress distribution while preventing excessive implant overload.[3] If the posterior soft tissue is not firm and tends to shift under pressure, a PM-3 or greater attachment system is essential for maintaining stability and fit in ISODs. Direct occlusal loading on anterior implants plays a crucial role in enhancing the stability of ISODs and full-arch prostheses. By ensuring that forces are directed along the long axis of the anterior implants, tipping is minimized, and overall support for the restoration is optimized. Cantilever length directly magnifies occlusal forces, significantly increasing stress on the implants and surrounding bone. This follows the lever principle, where force increases proportionally to the cantilever length. Example- a 25-lb load to a 10-mm cantilever results in a 250-lb mm force. Avoiding the restoration of the second molar in mandibular ISODs is a strategic approach to reduce the hidden cantilever effect, which can lead to excessive occlusal forces and biomechanical complications.

In the maxilla, appropriate crown height space (CHS) is critical for ensuring prosthetic stability, durability, and optimal biomechanics in implant-supported rehabilitations. The recommended dimensions are:

- Anterior CHS:15 mm
- Posterior CHS:12 mm

Relief is provided over the top of the implant distal to the bar to allow PM (platform matched) toward the tissue under posterior occlusal forces.

When force factors are greater (e.g., strong bite force, parafunction, heavy occlusion), the second molar sites increase the anterior-posterior (A-P) spread, improving the biomechanics and stability of the implant-supported prosthesis. For maxillary full-arch implant-supported prostheses, the recommended occlusal scheme follows these principles:

- Centric occlusion (CO) evenly distributed around the arch
- Anterior contact only during mandibular excursions
- Exception: If opposing a mandibular denture, balanced occlusion may be required

If the patient wears maxillary and mandibular overdentures (Ods), only the mandibular restoration needs to be removed at night.

Some of the occlusal factors in implant supported overdentures are as follows [4]:

➢ Occlusal concepts play a crucial role in achieving optimal function, comfort, and longevity of dental prostheses, including implant-supported ODs. The three well-known occlusal concepts-balanced occlusion, group function occlusion, and mutually protected occlusion-can be modified when designing occlusion for implant-supported ODs due to the

differences in biomechanics compared to natural teeth.[5,6].

➢ Several studies suggest that while occlusal schemes play a role, their impact on the long-term success of ISODs may not be as significant as previously thought. Instead, biomechanical factors, including tooth morphology modifications, are more crucial in reducing complications such as crestal bone resorption and implant failure.[7]These issues can be effectively managed through several clinical strategies that focus on reducing biomechanical risks and optimizing implant-supported OD function.[8].

The ODs are susceptible to several biomechanical complications which are as follows:[9]

➢ *Implant Overload*: Excessive occlusal forces are a major factor contributing to implant failure and crestal bone loss. Since implants lack the shock-absorbing periodontal ligament, they cannot adapt to excessive forces the way natural teeth do. This makes occlusal adjustments and cusp inclination modifications essential for ISODs.

➢ *Attachment Failures*: Attachments and abutments in ISODs are subject to functional stresses, which can lead to loosening, wear, or fracture over time. These complications can affect the stability and longevity of the prosthesis. Regular maintenance and monitoring are essential to prevent and manage these issues effectively.

➢ *Denture Fracture*: Fracture of the overdenture is a common complication, particularly in areas surrounding the implants where stress concentration occurs. Proper design, material selection, and occlusal adjustments are essential to minimize this risk and ensure the longevity of the prosthesis.

➢ *Bone Resorption*: While implants help preserve bone by stimulating the surrounding tissues, uneven loading, implant failure, or excessive occlusal forces can lead to bone resorption, affecting the long-term stability of the OD. Regular monitoring of bone levels is crucial for early detection and intervention to prevent further complications.

➢ *Peri-implantitis*: Peri-implant inflammation is a significant concern in ISODs. Poor oral hygiene can lead to plaque accumulation, which may cause peri-implant mucositis (reversible inflammation) or progress to peri-implantitis (bone loss and implant failure). Proper hygiene and regular maintenance are crucial for long-term implant success.

Minimizing complications in ISODs requires a comprehensive approach that addresses occlusal forces, prosthetic design, and implant biomechanics. By ensuring passive fit, proper occlusal adjustments, and optimal implant placement, long-term success and stability can be achieved. There were various cases involving opposite dentition such as an implant-fixed superstructure, natural dentition, implant overdenture, and complete denture. If there is concern about the bone quality surrounding the implant abutment, the condition of the opposing dentition must be fully considered, and selecting a connecting attachment may be appropriate if strong occlusal forces are expected.[10]

2. OCCLUSION IN IMPLANT SUPPORTED FIXED PROSTHESIS:

The occlusal guidelines have been established for various scenarios involving implant supported prosthesis. The goal of the guidelines is to maximize patient comfort and function while minimizing prosthetic complications.

(a) Metal-acrylic vs Metal-acrylic
(b) All-ceramic vs All-ceramic
(c) All-ceramic vs Metal-acrylic

The Guidelines are as follows:[11]

(a) Metal-acrylic vs metal-acrylic:

Simultaneous bilateral centric contact is a key factor in achieving a stable and functional occlusion, particularly in implant-supported restorations. Reduced occlusal forces should be delivered on the anterior teeth and distal cantilevers by providing clearance of Shimstock (~10μm) in occlusion. Slight relief in occlusal forces in the distal cantilevers can reduce the risk of fracture and over-stressing the terminal implant and abutment. In metal-acrylic full-arch prostheses, anterior denture teeth are often considered a weak point. As they are typically narrower mesio-distally and bucco-lingually compared to posterior teeth and have less surrounding denture resin, particularly along the labial surface. Moreover, anterior teeth often endure occlusal forces at an off-axis angle, exerting pressure on the labial surface. Priest et al. also noted that fractures of anterior teeth are more frequent than those of posterior teeth in metal-acrylic full-arch prostheses. Schuyler recommends incorporating freedom in centric when designing centric contacts. Integrating 1.0–1.5 mm of flattened occlusal surfaces provides a certain degree of freedom from the centric position. Allowing freedom from the centric position enhances patient comfort, particularly for completely edentulous individuals who have lost proprioception. Group function is advised for laterotrusive movements.

Distributing the occlusal load among the posterior teeth helps prevent canine denture teeth from experiencing excessive occlusal stress during excursive movements. According to Abduo, group function occlusion facilitates a broader and shallower chewing pattern, differing from the chewing patterns observed in canine guidance occlusion[12].

In group function occlusion, several teeth on the working side, including canines, premolars, and occasionally molars, come into contact during lateral jaw movements. Thus, this contact disperses occlusal forces across multiple teeth, promoting a broader and shallower chewing pattern compared to canine-guided occlusion, where only the canines bear the lateral forces. Group function occlusion is especially beneficial when canine guidance is not possible, such as when the canines are missing, weakened, or misaligned. By engaging multiple posterior teeth, this method ensures an even distribution of functional load, which may help minimize the risk of overloading any individual tooth. Canine-guided occlusion encourages a vertical chewing pattern and minimizes tooth wear by ensuring that only the canines make contact during lateral movements, thereby shielding the posterior teeth from lateral forces.[13]

Group function occlusion provides greater mandibular freedom, enhancing patient comfort and reducing mechanical stress on prostheses during function. Excursive contacts on the distal cantilever have been shown to cause fractures; therefore, they should be avoided.[14] A shallow anterior guidance in protrusion is recommended to reduce occlusal forces. Occlusal forces should be evenly distributed across the incisors, from centric contact to the edge-to-edge position.[15] A slight vertical overlap of the anterior teeth is necessary to establish anterior guidance, which also enhances the esthetic outcome.

(b) All-ceramic (Zirconia) vs all-ceramic (Zirconia) [11]:

The recommendation of CO for all-ceramic full-arch prostheses differs from that of metal-acrylic prostheses in one key aspect. With a monolithic, milled design, the weak link effect of anterior denture teeth seen in metal-acrylic prostheses is eliminated. This allows for more evenly distributed occlusal contacts across both the anterior and posterior regions. A broad and even distribution of occlusal forces is particularly beneficial for high-strength ceramics like zirconia, where material flexibility is highly limited. The distal cantilever, however, should still exhibit shimstock clearance (10μm). A common complication of porcelain-fused-to-zirconia restorations is chipping of the veneering porcelain. Short-term studies have shown that full-arch implant-supported prostheses made from either full-contour monolithic zirconia or zirconia with layering porcelain limited to the facial/buccal surfaces achieve very high prosthetic success rates. To reduce the risk of porcelain chipping, particularly in high-risk patients such as those with bruxism, it is recommended to incorporate zirconia on the incisal and occlusal surfaces.

(c) All-ceramic (Zirconia) vs metal-acrylic [11]:

When an all-ceramic full-arch prosthesis opposes a metal-acrylic prosthesis, the anterior denture teeth serve as the weak link. To reduce the risk of anterior denture tooth fracture, especially when the mandibular denture is metal-acrylic, a shimstock clearance of 10μm on the anteriors is recommended.

3. OCCLUSION IN ALL ON 4:

➢ **OCCLUSAL SCHEME:** There should be presence of bilateral identical intercuspal contacts when the jaws are stable. Occlusal adjustment helps establish bilateral occlusion in the canine and first bicuspid region.[16] Occlusal contact should be avoided in the distal-most region of the prosthesis. [17] The occlusal scheme should incorporate "freedom in centric." No interference should be present between the maximal intercuspal position and the retruded position. During lateral and protrusive movements, there should be light tooth contact while allowing free mandibular motion to prevent excessive wear or interferences.

➢ **IMMEDIATELY LOADING ALL ON FOUR, OCCLUSAL SCHEME:**[18]

The cantilever length should always be kept to a minimum. Bilateral, simultaneous contact should be present across all teeth, except those distal to the implant's emergence. During lateral movements, group function or guidance can be provided with flat, linear pathways and minimal vertical superimposition, excluding the cantilever teeth. In protrusive movements, guidance should be distributed across all anterior teeth, from canine to canine, using flat linear pathways with minimal vertical superimposition. No balancing contacts should be provided when an implant-supported fixed prosthesis opposes a removable prosthesis.

➢ **OCCLUSAL SCHEME FOR DEFINITIVE PROSTHESIS FOR ALL ON FOUR:**[18]

Simultaneous bilateral contact should be

maintained on the cuspids and posterior teeth, with slight grazing contacts on the incisors. Group function occlusion should be provided when an opposing implant-supported bridge is present in the posterior, utilizing flat linear pathways with minimal vertical imposition. If an implant-supported fixed prosthesis opposes a removable partial denture, complete denture, cast partial denture, or implant-supported overdenture, the distal-most tooth should be kept slightly out of occlusion. Additionally, in excursive movements, one or more balancing contacts should be provided. The inclination of the cuspal planes should be less than that of the condylar path inclinations.

4. OCCLUSION IN ALL ON 6:

Centric contacts should be evenly distributed, small, and centered over the implants. Eccentric contacts should involve only anterior guidance, distributed across multiple teeth. To minimize shear forces while ensuring posterior disocclusion, the angle of tooth contact should be as shallow as possible. The jaw-to-jaw position should be maintained in centric relation, as defined by Dawson, to achieve precise control of tooth contacts. The vertical dimension of occlusion (VDO) should be adjusted as needed to maintain proper tooth form and guidance.

With these occlusal adjustments, bite forces will primarily exert compressive pressure on the prosthesis, implants, and surrounding bone. If the implants contribute to guidance, stress is mitigated by distributing forces across multiple anterior teeth. Additionally, maintaining a shallow tooth-contact angle helps reduce vertical cantilevers—known stress magnifiers—thereby minimizing stress on the implant system.[19]

CONCLUSION:

In implant dentistry, the absence of a periodontal ligament increases the risk of occlusal overload, adding to the challenges of occlusal management. Poor occlusal design or discrepancies can lead to implant-related complications such as screw loosening, implant fracture, bone loss, and restoration failure. Additionally, occlusal discrepancies may contribute to temporomandibular joint disorders and muscle fatigue, highlighting the importance of achieving a harmonious occlusion in implant-supported restorations, as discussed in this article.

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Conflicts of Interest

There are no conflicts of interest.

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Review Article

Advances in Digital Prosthodontics: A Scoping Review of CAD/CAM and 3D Printing

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ABSTRACT:

The integration of digital technologies in prosthodontics has revolutionized dental practice by significantly enhancing accuracy, efficiency, and patient-centered outcomes. Traditional prosthodontic workflows, which have relied on manual impressions, wax modeling, and labor-intensive fabrication processes, are increasingly being replaced or supplemented by advanced digital techniques. This scoping review systematically analyzes peer-reviewed literature from key databases (PubMed, Scopus, and Web of Science) to evaluate the impact of Computer-Aided Design and Computer-Aided Manufacturing (CAD/CAM) and 3D printing, on prosthodontic treatment planning and prosthesis fabrication.

Findings indicate that CAD/CAM technology improves prosthetic accuracy by up to 30% compared to conventional methods, with milled restorations demonstrating higher marginal adaptation and reduced remakes. Similarly, 3D printing reduces material waste by 50% while enabling rapid and customizable prosthesis fabrication.

KEY WORDS: Digital prosthodontics, CAD/CAM, 3D printing, Digital, workflows

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INTRODUCTION:

Prosthodontics, the dental specialty focused on the restoration and replacement of teeth, has undergone significant transformations with the advent of digital technologies. Traditional workflows in prosthodontics have historically been labor-intensive and time-consuming, involving manual impressions, wax modeling, and casting procedures. These conventional methods, while effective, often present challenges related to accuracy, patient comfort, and procedural efficiency. The integration of digital technologies, such as Computer-Aided Design and Computer-Aided Manufacturing (CAD/CAM) and 3D printing.[1,2]

The introduction of intraoral scanners, for instance, has replaced traditional impression techniques with digital impressions, improving patient comfort and reducing procedure time.[3] CAD/CAM systems have enabled the design and fabrication of dental prostheses with high accuracy and reduced turnaround times, streamlining the workflow for dental professionals.[4] Additionally, the incorporation of AI in dentistry has facilitated more accurate diagnostics and personalized treatment planning, further enhancing the quality of prosthodontic care.[5]

This scoping review aims to systematically assess and compare CAD/CAM and 3D printing in prosthodontics, highlighting their advantages, limitations, and clinical implications.

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CAD/CAM IN PROSTHODONTICS:

Overview of CAD/CAM Technology:

CAD/CAM technology represents a significant advancement in prosthodontics, enabling the digital design and fabrication of dental prostheses. The process encompasses three primary stages:

Data Acquisition: This initial phase involves capturing the precise geometry of a patient's dentition. Intraoral scanners are commonly employed for this purpose, offering a digital alternative to traditional impression materials. These scanners utilize various technologies, such as confocal laser scanning and optical coherence tomography, to produce accurate 3D representations of the oral cavity. [6]

Design (CAD): The digital data obtained is then imported into specialized CAD software. Dental professionals can design the prosthesis with high precision, customizing parameters to meet the specific needs of the patient. This digital approach allows for meticulous planning and simulation before the actual fabrication.[7]

Manufacturing (CAM): Once the design is finalized, the CAM phase involves fabricating the prosthesis using milling machines or 3D printers. Milling machines carve the prosthesis from solid blocks of materials like ceramics or composites, while 3D printers build the prosthesis layer by layer using additive manufacturing techniques.[8]

Applications in Prosthodontics:[9]

CAD/CAM technology has been integrated into various prosthodontic applications, including:
Crowns and Bridges: The technology facilitates the creation of precise and well-fitting crowns and bridges, enhancing both function and aesthetics.
Inlays and Onlays: CAD/CAM allows for the fabrication of inlays and onlays with high accuracy, providing durable and aesthetic restorations for damaged teeth.
Implant Prosthetics: The technology aids in designing implant abutments and superstructures, ensuring optimal fit and function.

Advantages over traditional methods:[10,11]

The adoption of CAD/CAM technology offers several advantages over conventional prosthdontic methods:
Increased accuracy: digital impressions and designs minimize human error, leading to prostheses with superior fit and function.
Enhanced efficiency: the streamlined digital workflow reduces the time required for both designed and fabrication. In some cases, this enables same day restorations, significantly improving patience convenience.
Material Optimization: CAD/CAM systems can utilize a wide range of materials, including high-strength ceramics and composites, enhancing the durability and aesthetics of restorations.

Limitations:

Despite its numerous benefits, CAD/CAM technology has certain limitations:[11,12]
Initial Investment: The cost of acquiring and maintaining digital equipment can be substantial, potentially posing a barrier for some dental practices.
Learning Curve: Dental professionals must undergo training to effectively use CAD/CAM systems, which may require time and resources.
Material Compatibility: Not all materials used in traditional methods are compatible with CAD/CAM systems, which may limit certain treatment options.

3D PRINTING IN PROSTHODONTICS:

Overview of 3D Printing Technology:

3D printing, also known as additive manufacturing, has emerged as a transformative technology in prosthodontics, enabling the fabrication of dental prostheses with high precision and customization. This process involves creating objects layer by layer based on digital models, allowing for the production of intricate designs tailored to individual patient anatomies.[13]

In prosthodontics, 3D printing is utilized to fabricate various dental components, including dental models, surgical guides, and prosthetic elements such as dentures, crowns, and bridges. The technology facilitates the creation of restorations that closely match the patient's unique dental morphology, enhancing both function and aesthetics.[13]

Advantages Over Traditional Methods:[13,14]

The integration of 3D printing into prosthodontic practice offers several notable advantages over traditional manufacturing methods:
Customization:

3D printing allows for the production of patient-specific prostheses with complex geometries that are challenging to achieve with traditional methods. This customization leads to better-fitting restorations and improved patient satisfaction.

Material Efficiency:

Unlike subtractive manufacturing techniques,

Table 1: Comparison of flexural strength, biocompatibility, and clinical performance of materials used in CAD/CAM, 3D printing, and conventional methods.

Property	CAD/CAM Milled Materials	3D-Printed Materials	Conventional Materials
Trueness and Fit	High accuracy; requires fewer post-processing adjustments.	Moderate accuracy; may need post-processing for fit refinement.	Variable accuracy; technique-sensitive fabrication process.
Flexural Strength (MPa)	~120.6 MPa	~92.1 MPa	Variable; often lower due to polymerization shrinkage.
Surface Quality	Smooth, requires minimal finishing after milling.	Layer-by-layer fabrication may need polishing for smoother surfaces.	Requires extensive polishing and finishing for optimal esthetics.
Material Waste	Minimal; optimized milling paths reduce waste.	Low; additive manufacturing uses only the necessary material.	High waste due to manual adjustments and material errors.
Biocompatibility	High, with tested dental ceramics and composites.	Material-dependent; improvements ongoing in resin biocompatibility.	Dependent on operator technique and material selection.
Clinical Longevity	Longer lifespan due to controlled milling and material quality.	Variable longevity; research ongoing on material durability.	Dependent on manual fabrication accuracy and operator expertise.

which often result in significant material waste, 3D printing builds objects layer by layer, using only the necessary material. This approach reduces waste and can lower material costs.

Time Savings: 3D printing can lead to faster production times, especially for complex cases. The digital workflow streamlines the design and fabrication processes, potentially reducing the time required to deliver the final prosthesis to the patient.

Limitations:[15-17]

Despite its advantages, 3D printing in prosthodontics has certain limitations:

Material Properties: Some 3D-printed materials may lack the strength or biocompatibility of traditional/conventional materials. For instance, while materials like hydroxyapatite have been used in 3D printing for bone repair, challenges remain in matching the mechanical properties and biological responses of natural bone.

Surface Finish: Printed prostheses may require additional post-processing to achieve a smooth surface finish. The layer-by-layer construction can result in a rougher surface compared to traditionally manufactured prostheses, necessitating polishing or other finishing techniques to meet clinical standards.

Regulatory Considerations:

Ensuring compliance with medical device regulations can be challenging. The adoption of 3D printing in clinical settings requires adherence to stringent regulatory standards to ensure patient safety and the efficacy of the prosthetic devices.

Table 1 highlights the flexural strength, biocompatibility, and clinical performance of materials used in CAD/CAM, 3D printing, and conventional methods.

CONCLUSION:

The integration of CAD/CAM and 3D printing, has revolutionized prosthodontics by improving accuracy, efficiency, and clinical outcomes.

Digital workflows enhance precision, reduce treatment time, and improve patient experience with better-fitting prostheses and same-day restorations.

Despite these advantages, challenges such as high initial costs, the need for specialized training, and regulatory considerations hinder widespread adoption. However, continuous advancements in digital imaging, materials science will further refine these technologies,

making them more accessible and cost-effective.

As digital prosthodontics evolves, it is poised to become the standard of care, offering superior treatment predictability and patient satisfaction. Overcoming existing limitations through research, innovation, and education will ensure its successful integration into routine dental practice.

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Conflicts of Interest
There are no conflicts of interest.

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Review Article

Effectiveness of Sodium hypochlorite Chemotherapeutic Agents for Decontamination of Infected Dental Implant Surface: A Review Article

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ABSTRACT:

Peri-implantitis poses an imminent challenge to the field of implant dentistry. Peri-implant diseases are caused by bacterial biofilm colonizing implant surfaces. Prevention and management of peri-implant mucositis and peri-implantitis rely on effective biofilm removal. Etiological treatment of peri-implantitis aims to reduce the bacterial load within the peri-implant pocket and decontaminate the implant surface in order to promote osseointegration. Considering the promising findings of sodium hypochlorite and periodontal lesions, the aim of the review article is to evaluate the clinical effects of sodium hypochlorite oral rinse on peri-implantitis lesions.

KEY WORDS: Sodium hypochlorite, per-implantitis, chemotherapeutic agents

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INTRODUCTION:

Recently, oral implantology has become a key component of modern dentistry, significantly enhancing the quality of life for many patients. Dental implants are the optimal solution for replicating the appearance, sensation, and function of natural teeth. Not only do they replace missing teeth, but they also help preserve and strengthen the bone structure.

Peri-implantitis, however, is currently regarded as one of the most challenging biological complications related to implants, and if left untreated, it can ultimately result in implant loss.[1]

Peri-implantitis is described as a pathological condition affecting the tissues surrounding dental implants, marked by inflammation in the peri-implant mucosa and gradual loss of the supporting bone. Common features of peri-implantitis include bleeding upon probing, potential pus discharge, increased probing depths, and/or recession of the mucosal margin. The prevalence of peri-implantitis varies between 11.2% and 22%, with contributing risk factors including a history of periodontitis, smoking, diabetes, inadequate plaque control, and insufficient regular maintenance care.[2]

The management of peri-implantitis has proven to be quite challenging, partly due to the difficulty in adequately decontaminating the implant surface. This step is crucial for effectively resolving the bony defects caused by the disease.[3] In response to the increasing prevalence of peri-implantitis, conventional treatments are classified into two main categories: non-surgical (mechanical and chemical) and surgical methods.

Mechanical decontamination is carried out using various techniques, such as curettes, ultrasonic devices, or air-abrasive powder systems. Chemical decontamination methods typically involve agents that target the microbial biofilm in different ways, either by

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eliminating the bacterial populations, reducing the replication of existing species, and/or modulating the local environment [4].

However, surgical treatment is frequently recommended for the management of peri-implantitis, as it provides the surgeon with enhanced access to the implant surface, facilitating effective decontamination and allowing for the potential repair or recontouring of osseous defects.[5]

Sodium hypochlorite (NaOCl) (1%) exhibits broad-spectrum antimicrobial activity, rapid bactericidal effects, and relative non-toxicity at commonly used concentrations. It has demonstrated substantial bactericidal and fungicidal activity in experimental biofilms, particularly against various endodontic and periodontal pathogens. Subgingival irrigation with 0.5% NaOClresults in a significantly greater and more durable reduction in plaque and gingivitis compared to irrigation with water. Consequently, it has been utilized as an effective decontaminating agent for infected titanium surfaces of implants. Notably, NaOCl (1%) was found to be effective against all three species of microorganisms tested:

Staphylococcus epidermidis, *Candida albicans*, and *Streptococcus sanguinis*. An in vivo randomized controlled trial to assess the clinical efficacy of sodium hypochlorite rinses in periodontitis patients was performed. In this study, patients were instructed to rinse with 0.25% NaOCl twice weekly for 30 seconds over a three-month period. Using a 0.25% sodium hypochlorite oral rinse twice a week significantly reduced dental plaque levels and bleeding on probing, suggesting it may be a promising approach for managing periodontal disease.[6]

SODIUM HYPOCHLORITE:

Sodium hypochlorite is an alkaline inorganic chemical compound with the formula NaOCl (also written as NaClO). It is commonly known in a dilute aqueous solution as bleach or chlorine bleach. It is the sodium salt of hypochlorous acid, consisting of sodium cations (Na^+) and hypochlorite anions (^-OCl, also written as OCl^- and ClO^-).[7]

CONCENTRATION OF SODIUM HYPOCHLORITE FOR PERI-IMPLANTITIS:

NaOCl irrigant is used at concentrations varying between 0.5% and 6% with no consensus for the optimal concentration. NaOCl has shown positive results for oral rinse on peri-implantitis lesions regarding the reduction of periodontal probing depth and gingival bleeding index.

2.5% NaOCl for reduction of contamination on used healing abutments and showed significantly greater effectivity than air polishing. 1% NaOCl can be used to disinfect customized abutments. Similarly, 1% NaOCl can be applied for the cleaning of zirconia copings.[6]

CLINICAL USES:

- The Concentration of 3% NaOCl can be used for ultrasonication of titanium specimens NaOCl
- shows maximum significant effect on all three test microbes (C. albicans, S. sanguinis, and S. epidermidis).[8]
- NaOCl its active agent is undissociated hypochlorous acid (HOCl)– shows broad antimicrobial activity, rapid bactericidal action, and relative non-toxicity at common concentrations.
- NaOCl helps in reduction of periodontal probing depth and gingival bleeding index.
- 2.5% NaOCl for reduction of contamination on used healing abutments and showed significantly greater effectivity than air polishing.
- Also, 0.125%, 0.25%, and 0.5% NaOCl can be used for wound irrigation after surgical debridement for orthopaedic infections.
- Oral rinsing with 0.1%–0.25% NaOCl was used to improve periodontal health.[6]
- It has chemotherapeutic effect on reosseointegration after treatment of peri-implantitis.[9]
- Biofilms grown on sandblasted, large-grit, acid-etched titanium discs can be treated with a titanium brush with 1.0% NaOCl and 0.2% chlorhexidine.[8]

Limitations:

NaOCl may cause chemical burn, tissue necrosis, upper airway obstruction and can corrode titanium surface.[10]

EFFECT ON PERI-IMPLANTITIS:

- 0.95 % NaOCl and 1mg minocycline in conjunction with ultrasonic debridement and soft tissue curettage synergistically reduces probing depth and bleeding on probing.
- NaOCl and hydrogen peroxide represent traditional dental disinfectants that are widely used for reducing biofilm accumulation on removable prostheses.

- For regeneration of peri-implantitis defects, autografts are used.However, use of 1.5% NaOCl leads to most favourable results in terms of changes in defect depth and percentage of reosseointegration.
- 0.1% NaOCl with titanium brush and chlorhexidine is used for decontamination during peri-implantitis treatment.[6]

ZINC OXIDE NANOPARTICLES ENHANCES THE EFFICIENCY OF SODIUM HYPOCHLORITE:

The use of nanoparticles based on metals and their oxides are seen as a potential next-generation agent with antibacterial activity. There is a growing interest towards Zinc oxide nanoparticles (ZnO NPs) because of its unique physical and chemical properties e.g., antimicrobial, high catalytic, large excitation binding energy, UV filtering properties, photochemical activity, low toxicity, biocompatibility, and high photostability.

NaOCl disinfectant and ZnO nanoparticles exhibit significant antibacterial activity against bacteria *Escherichia coli*, *Salmonella* Typhimurium, *Staphylococcus aureus* and *Listeria monocytogenes*, with a synergistic effect achieved in their combination. Outcomes have revealed that the doping of manganese and cobalt in ZnO nanoparticles played a noteworthy part in inhibiting the growth of both gram-positive bacteria.[11]

The increasing number of dental implants used for tooth replacement and the extension of implant indications for high-risk patients, such as smokers and patients after irradiation, have resulted in increased number of patients with peri-implant mucositis and peri-implantitis requiring adequate therapeutic strategies. Unfortunately, treatment recommendations for peri-implant infections remain unclear. The key to success in the treatment of peri-implantitis is the decontamination and disinfection of implant surfaces.

Antimicrobial mouth-rinses and rinsing solutions are a common adjunct to mechanical debridement to facilitate the control of supragingival and subgingival plaque. Several of these traditional antiseptics have been proposed for the non-surgical therapy of mucositis and periodontitis as well as peri-implant mucositis and peri-implantitis. NaOCl with its active agent undissociated hypochlorous acid (HOCl) is a traditional disinfectant in dentistry because of its bactericidal, fungicidal, and tissue dissolving properties' is mainly used in endodontic therapy, and its proposed concentrations range from 0.5% to 5.25%. HOCI is effective against bacteria because of its oxidizing action and has been successfully used as a supportive antimicrobial agent in surgical peri-implantitis therapy.[8]

NaOCl was applied against three peri-implantitis-associated microbiota strains (Staphylococcus aureus, Staphylococcus epidermidis, and Candida albicans). Moreover, NaOCl has been used for recycling of implant healing abutments and this results in no bacterial contamination. Oral rinsing with NaOCl twice weekly is used as an available adjunct to conventional anti-plaque and anti-gingivitis treatments. NaOCl and minocycline in conjunction with ultrasonic debridement and soft tissue curettage leads to synergistic effect on reduction of probing depth and bleeding on probing.

Application time varries among studies. For wound irrigation after surgical debridement for orthopedic infections, NaOCl is applied for different time intervals 1-, 5-, and 10-min. NaOCl is applied for 5 min to disinfect customized abutments. To evaluate the efficacy of antibacterial sealing gel, 2% NaOCl solution is applied for 30 min. NaOCl is applied for 1 min to clean the retentive attachments in dentures. NaOCl is applied for 1 min for antibacterial effects on a titanium surface.[6]

CONCLUSION:

The concentration of 0.25% can be used for treatment of peri-implantitis. Also, Regeneration of peri-implantitis defects using autograft with or without resorbable membrane can achieve some reosseointegration, Additional chemical treatment with 1.5% NaOCl leads to the most favorable results in terms of changes in defect depth and percentage of reosseointegration.

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Conflicts of Interest

There are no conflicts of interest.

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Review Article

The Impact of Vitamin Deficiencies in Oral Cavity: A Review

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ABSTRACT:

Vitamins are organic compounds and are derived from diet. They are required for proper growth, development and normal activity of body tissues. They play an important role in maintenance of oral health of an individual. They can be fat soluble or water soluble. The initiation, pathogenesis and increase in severity of oral and periodontal diseases, depends on the presence of vitamins in the body. Deficiency of vitamins can lead to increased risk of dental caries. They have a significant impact on the development of enamel, dentin and bone formation in the oral cavity. They affect the periodontal health of an individual.

KEY WORDS: vitamins, energy, growth, development vitamins

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INTRODUCTION:

Vitamins are organic compounds that regulate metabolism, growth and energy supply of the body. Proteins, carbohydrates and fats influence the functioning of vitamins. They are of two types,fat soluble vitamins which include vitamin A,C,D,E, and K whereas water soluble vitamins include vitamin B and C.[1] Vitamins affect the initiation, pathogenesis and increase in severity of oral diseases, such as dental caries, gingivitis and periodontitis.[2] Casimir Funk, in the year 1912, named these organic substances "vitamine". They are either obtained from food, where they are present in small amount, or they are derived from provitamin. The maintenance of appropriate growth, development and wellbeing of a person depends upon the presence of vitamins.[3] This detailed review shall highlight the importance of Vitamins in health and oral diseases.

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VITAMIN A (retinol):

Vitamin A is absorbed into intestinal luminal cells, where the precursors (beta carotene) are activated and transferred to chylomicrons. These chylomicrons consists of carotenoids, retinyl esters, triglycerides and unesterified retinol, and they travel through lymphatic system and reach extra hepatic tissues, where triglycerides are produced. Vitamin A remnants are moved to liver and retinol can be obtained from liver with the help of specific carrier. It is essential for normal vision, normal growth, development and regulation of epithelial cellular integrity, immunity and reproduction. Night blindness can occur due to its deficiency.[4] Oral manifestations caused due to its deficiency are enamel hypoplasia, reduced odontoblast differentiation and impairment of dentin production.[1] Deficiency of this vitamin can also lead to gingivitis, periodontitis, dental caries, xerostomia, white patches which are hyperkeratotic and impairment in tooth morphogenesis.[4] In some experiments, it was observed

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that deficiency of vitamin A can lead to increased cell production(indicating precancerous changes) and hyperkeratosis of gingiva. There is increased risk of formation of periodontal pockets and atrophy of salivary gland in such patients. Retinoids can enhance the immune response of the body, activate cellular differentiation process and trap the free radicals preventing them from causing damage to healthy cells of the body, thus, preventing development of tumors. The major sources include milk, eggs and green vegetables.[3]

VITAMIN D:

Vitamin D acts as prohormone. On exposure to sunlight, 7-dehydrocholesterol is converted into cholecalciferol and 25-hydroxycholecalciferol is generated. Calcitriol is active form of this vitamin. The major actions include bone formation, development of teeth and initiation of enamel mineralization. It connects to vitamin D receptor(VDR),which is present in teeth and bones and regulate differentiation of ameloblasts and odontoblasts. The rise in calcium absorption and suppression of inflammation are also some of its actions.[5] If there is less calcium and phosphate levels in the body, it results in rickets in infants and children and osteomalacia in adults, due to deficiency of vitamin D. Clinical features of rickets include tetany, craniotabes, swelling of wrists and ankles,short stature and distortion of the limbs. Oral manifestations include enamel hypoplasia, defect in tooth eruption, blurring of lamina dura, thinning of mandibular canal and decrease in number, density and thickness of trabeculae with radiolucent radiographic appearance. Osteomalacia shows pain in bones, muscular weakness and tetany. Oral manifestations include thinning of lamina dura and decrease in trabeculae with radiolucent radiographic appearance. [6]

Vitamin D controls both innate and adaptive immune responses of the body. The synthesis of defensins and cathelicidin, which are antimicrobial peptides, is controlled by vitamin D and this immunological function provides protection against diseases caused by oral bacteria. Vitamin D protects teeth and gums by controlling calcium phosphate balance in the body. It also obstructs the development of dental caries because it plays an important role in digestion and absorption of calcium, magnesium and phosphorus, which are required for normal development of bones and teeth. In premalignant lesions and oral cancer, VDR expression was found to be increased, so administration of vitamin D can cause decrease in therapy related toxicities in later stages of oral malignancies. This leads to reduction in morbidity. During orthodontic treatment, controlled mechanical stimulus is required for tooth movement, so that it can cause bone resorption at pressure site with the help of osteoclastic action and bone formation at tension site with the help of osteoblastic action. The increase in speed of tooth movement can result due to this process, and it was observed that administration of vitamin D can facilitate the increase in speed of tooth movement. The antiproliferative, immunomodulatory and anti-inflammatory activity of vitamin D, along with its capacity to stimulate cell apoptosis, results in prevention of resorption of alveolar bone. It also reduces the progression of gingivitis and chronic periodontitis.[5]

VITAMIN E:

Vitamin E comprises of eight different compounds, which are four tocopherol and four tocotrienols, out of which alpha tocopherol is most active.[1] It is a free radical scavenger in cell membranes and is lipid soluble. This vitamin has antioxidant and anticarcinogenic properties. It obstructs generation of nitrosamine, which is carcinogenic, and enhances immune response of the body. It helps in prevention of premalignant lesions of oral cavity.[2] It saves the cell membrane from oxidative damage. Deficiency causes disturbance in red blood cells, muscular dystrophy, disturbance in blood vessels, pigmentation loss and deterioration of enamel organ. Green leafy vegetables, plant oils and egg yolk are some of the major sources.[3]

VITAMIN K:

It is a fat soluble vitamin and has two natural forms vitamin K1 and vitamin K2.The functions of vitamin K include maintenance of calcium metabolism, cell growth, oxidative stress, inflammatory actions, bone stability and blood clotting.[2] The generation of blood clotting factors require vitamin K, which acts as a catalyst. This is required for maintenance of prothrombin levels.[1] The calcification of bone matrix, improvement of bone regeneration ability and transformation of dental pulp stem cells into osteoblasts, are enhanced by this vitamin. In vitro studies were conducted, in which it was found that vitamin K can prevent dental caries. There is elevation in reactive oxygen species and oxidative stress in the hypothalamus due to increased consumption of sugar. It leads to obstruction in normal flow of dentinal fluid and oral bacteria can damage the tooth surface by generating acid which has the tendency to demineralize the enamel. This can cause damage to dentin and the matrix metalloproteinases of the body show dentin breakdown. The preservation of endocrine regulated

normal flow of centrifugal dentinal fluid is caused by vitamin K2. It occurs due to its capacity to generate antioxidant activity in the brain. It plays a major role in buffering of the saliva.[2]Deficiency can cause defect in production of prothrombin. The risk of gingival bleeding is common in such cases. Sources of this vitamin include green leafy vegetables and milk.[3]

VITAMIN C:

Vitamin C is also called ascorbic acid. It is a water soluble vitamin and is present in diet. It is a hydrophilic antioxidant.[7] It plays an important role in collagen production. It enhances strength of blood vessels and body tissues, thus playing an important part in the process of wound healing. It promotes evolution of erythrocytes by increased absorption and utilization of iron.[1] It facilitates calcium deposition and mineralization, which decreases the possibility of development of dental caries. Eydou et al conducted a study which demonstrated that there is inhibitory effect, which is concentration dependent, between vitamin C and *Streptococcus mutans*. *Streptococcus mutans* is a bacteria which is associated with initiation of dental caries. The deficiency of vitamin C causes scurvy,a disease identified by the presence of bleeding and swelling in gingiva, increased tooth mobility, damage of periodontal ligament and deterioration of ameloblasts and odontoblasts. Defective wound healing, fatigue and depression can occur due to deficiency of this vitamin. Vitamin C obstructs the progression of inflammation caused due to periodontal disease. It can decrease deposition of supragingival calculus. It can obstruct the beginning of carcinogenesis due to its antioxidant property. A study was conducted in which patients suffering from oral cancer were observed and it was found that there is reduction in vitamin C levels in the saliva of patients suffering from oral cancer, when they were compared with control group. In a case control study, it was observed that the initiation and progression of oral premalignant lesions was obstructed in individuals consuming vitamin C in diet.[7]Citrus fruits and vegetables are some of the sources.[3] Cigarette smoking decreases vitamin C level in plasma because of elevated turnover. During exercise or in conditions associated with metabolic stress, there is theoretical proof for increased demand of vitamin C. In cases of patients who have undergone surgical management or patients who are suffering from infection, plasma concentration of vitamin C is decreased as the utilization by body tissues is increased.[7]

VITAMIN B1 (THIAMINE):

Vitamin B1,also known as thiamine, plays an important role in energy metabolism, cerebral metabolism and generation of neurotransmitters. It helps in maintenance of cell membrane, cellular differentiation, axonal development, synapse synthesis and prevents cytotoxicity. Thiamine pyrophosphate is active form and plays an important role in energy metabolism by acting as cofactor for enzymes. These enzymes play a crucial role in carbohydrate catabolism. Beriberi disease, dry and wet beriberi, can result due to its deficiency. The clinical features of dry form include pain in calf muscle, atrophy of calf and thigh muscles, burning sensation in feet, muscle cramps, pain in legs, and paresthesia of toes causing absence of vibratory and position sensation in toes. The wet form features include peripheral vasodilation, tachycardia, high cardiac output, lactic acidosis and heart failure. Wernicke encephalopathy affects mostly alcoholics due to improper diet and diet consisting of excessive carbohydrates as it increases metabolic requirements of thiamine. Clinical features include nystagmus, ptosis, aphonia, hypothermia, ophthalmoplegia, loss of muscle control and lack of vibratory sensation and coordination.[8] Oral manifestations include increased sensitivity of oral mucosa, deterioration of oral mucosa, and presence of vesicles in the oral cavity.[3]There can be presence of erythematous and edematous tongue.[1] The sources of this vitamin include cereals, beans and nuts.[3]

VITAMIN B2(RIBOFLAVIN):

Riboflavin is a water soluble and heat stable vitamin. It comprises of antioxidant activity and can alleviate lipid peroxidation. It can function as photosensitiser. Fortified grains, cereals, peas and dairy products are some of the sources where this vitamin is found. Aerobic cells generate free radicals causing ageing and chronic diseases. This leads to destruction of cellular macromolecules like DNA, damage to body tissues, inflammation and cellular apoptosis. Malignancies such as cancer are accompanied by oxidative stress. Several studies have been done which showed the antioxidant activity of riboflavin as it protects the body from damage caused by free radicals. Reactive oxygen species (ROS) is a term given to oxygen metabolites. An in vitro study was conducted which showed that riboflavin reduction in intestinal cells can cause excessive generation of ROS. An animal study was conducted in which MDA (malondialdehyde), which is an indicator of lipid peroxidation is reduced after riboflavin is given in rat model associated with renal toxicity. Riboflavin has prooxidant activity. When it absorbs ultraviolet radiation and bluelight, it

functions as photosensitiser. Although it is not toxic in darkness but the photoreactivity of riboflavin is due to the isoalloxazine moiety. As a result, it plays an important role in anticancer photodynamic therapy.[9]It plays an important role in the metabolism of carbohydrates, proteins and fats, causing generation of cellular energy.[11]It facilitates normal vision and plays an important role in maintenance of healthy skin.[3] Deficiency can cause angular cheilosis, anaemia and dermatitis. Thelips become erythematous and smooth. There is deterioration of fungiform papillae, which becomes mushroom shaped. There is atrophy of tongue .The tongue can attain magenta colour because of proliferation of blood vessels and reduced blood supply.[1]

VITAMIN B3 (NIACIN):

Redox and adenosine diphosphateribosylation reactions need niacin. The NAD (nicotinamide adenine dinucleotide) pool exists in oxidized condition and it plays an important role in oxidative pathways, like glycolysis and tricarboxylic acid cycle (Krebs cycle). There is reduced state of NADP (nicotinamide adenine dinucleotide phosphate) pool and it plays an important role in anabolic pathways like generation of fatty acid and oxidant defense.[10] The deficiency leads to pellagra, whose clinical features include photo distributed rash transforming into chronic dermatitis, gastrointestinal, neurologic and psychiatric problems. The main features include dermatitis, diarrhea, dementia and even death. Initially, the lesion is erythematous but in advanced stages it becomes dry, dark and scaly. Lesions on the neck are called “castle's necklace”. It can occur in all ages but 30-40 years old male patients are mostly found.[11] Oral manifestations include painful stomatitis. There is edematous, smooth and shiny tongue, where pain can be felt by the patient. There is destruction of filiform and fungiform papillae.[1] Meat, cereals and pulses are some of the sources of this vitamin.[3]

VITAMIN B6 (PYRIDOXINE):

Vitamin B6 plays an important role in the metabolism of carbohydrates, amino acids, lipids and nucleic acids. It helps in cellular signaling and has antioxidant property.[12] Green leafy vegetables, meat and fish are some of its dietary sources.[3] Pyridoxal phosphate (PLP) is its active form and is synthesized by yeasts and bacteria. It plays an important role in glycogen breakdown. It is also involved in transformation of amino acid, where it acts as a coenzyme in transamination and reactions causing decarboxylation. It influences the functioning of inflammasomes, so, it has anti-inflammatory action. It controls blood pressure by acting on rennin angiotensin system and regulates blood clotting, causing stability of endothelium and platelet aggregation. Mikkelsen conducted a study and found that vitamin B2 (riboflavin),vitamin B6(pyridoxine), and vitamin B9 (folic acid) can produce antitumor action on promonocytic lymphoma cell lines. The result indicated that vitamin B can obstruct development of malignancy. It was found that vitamin B2, B6 and B9 increased the production of interleukin 8 and interleukin 10 by the cells of the monoblasticleukemia cell line compared to control groups. Vitamin B6 is a cofactor of the enzyme kynureninase and leads to the synthesis of anti-inflammatory molecules. This can obstruct the development of cancer in vivo.[12] Depression, mental confusion, hypochromic microcytic anaemia and leucopenia are some of the deficiency features.[3] Glossitis is common causing erythema and hypertrophy of filiform papillae. Scalded sensation of tongue is observed. Pain can be felt by such patients.[1]

VITAMIN B9 (FOLIC ACID):

Folic acid plays an important role in synthesis of blood cells, protein metabolism and formation of DNA. Green leafy vegetables, fortified grain products and milk are major sources of folate.[3] Less thymidine can cause folate deficiency, hypomethylation of DNA and destruction of DNA. Folate metabolism is essential for cell replication and cell existence. It helps in treatment of megaloblasticanaemia. Folate deficiency can cause macrocytic anaemia, memory loss, confusion, weakness, difficulty in breathing, peripheral neuropathy, malignancy and difficulty in pregnancy.[13] Oral manifestations include glossitis and chronic periodontitis. There is increased mobility of teeth in such patients.[1]

Some observational studies were conducted which indicated that hyperhomocysteinemia can cause cardiovascular related disorders. There is increased plasma homocysteine levels in such patients and it can lead to atherosclerosis and coronary artery diseases. Homocysteine can cause atherogenesis and thrombogenesis which can result in the development of fibrosis and hyperplasia of muscle cells. Folic acid can decrease plasma homocysteine levels in the body.Larger scaled randomized trials should be done for better observation. Qin et al conducted a study in which it was observed that there is decrease in progression of cardiovascular disease, when folic acid was given in such patients. But trials involving large sample sizes should be done. Title et al conducted a

study on patients suffering from type 2 Diabetes Mellitus, who were given folic acid, versus placebo and it was found that folic acid improved endothelial dysfunction. Folic acid can cause better glycemic control.[13]

VITAMIN B12 (COBALAMIN):

Vitamin B12 plays an important role in the synthesis of erythrocytes, nucleic acids and myelin. It plays an important role in catabolism of specific amino acids and fatty acids.[1]Bacteria, yeasts, molds are the sources of this vitamin. Deficiency of vitamin B12 can lead to pernicious anaemia, breathlessness, fatigue, weakness, dementia, macrocytosis, sclerosis of spinal cord, jaundice, Hunter's glossitis, ataxia, mucocutaneous ulcers and increased levels of bilirubin .Oral manifestations include burning sensation of tongue, glossitis, angular stomatitis, angular cheilitis, recurrent oral ulcers, oral candidiasis ,distortion of oral mucosa and defect in taste sensation .[14]

VITAMIN B5 (PANTOTHENIC ACID):

Pantothenic acid is a water soluble Bcomplex vitamin and is also known as vitamin B5. It blends into coenzyme A and acyl carrier protein. It is produced by plants, bacteria and fungi. Some of the dietary sources include eggs, yeast, oats, tomato, potato, beef and chicken. Royal bee jelly has very high amount of this vitamin. Coenzyme A participates in several enzymatic process including oxidation of fatty acid, amino acid catabolism, carbohydrate metabolism, pyravate breakdown, heme formation and generation of acetylcholine. Acyl carier protein plays an important role in elongation of fatty acid because it is a part of structure containing fatty acid synthase.[15] In some experimental animals, it was observed that deficiency of pantothenic acid leads to anaemia, reduction in production of steroid and fatty liver but no features, associated with deficiency, were observed in human beings.[3]

VITAMIN B7 (BIOTIN):

Biotin is a water soluble vitamin. It is an important cofactor for carboxylase enzymes which start functioning as soon as they are connected by holocarboxylase synthase.Various metabolic processes like production of fatty acid, gluconeogenesis and amino acid catabolism require these enzyme complexes. Biotin plays an important role in generation of keratin and helps in development of nails and hairs. Unpolished rice, whole grains, egg yolk and nuts are some of the dietary sources of this vitamin. Deficiency symptoms include eczematous skin rashes, conjunctivitis, alopecia, seborrheic dermatitis, seizures, hypotonia, depression and lethargy.[16] The use of raw egg whites for long duration can cause biotin deficiency. Oral manifestations include paleness of tongue and destruction of lingual papillae.[1]

CONCLUSION:

There is increased requirement of water soluble vitamins as coenzymes due to high metabolic rate. There can be increase in requirement of antioxidant vitamins, for example vitamin E and vitamin C, due to rise in oxidative metabolism causing more generation of reactive oxidant species. Also, there is variation in spread of vitamins in body fluids. The decrease in carrier proteins can cause less concentration of vitamins in plasma. If there is decrease in plasma concentration of retinol binding protein, the concentration of vitamin A is decreased. In patients undergoing renal dialysis, there is loss of water soluble vitamins. Laboratory analysis of vitamins is not common but some tests, involving intracellular measurement of vitamins, can be done for research work.

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Conflicts of Interest

There are no conflicts of interest.

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Review Article

Quest for the Best Cure: A Comparative Literature Review of Dry Socket Treatment Modalities

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ABSTRACT:

Dry socket, also known as alveolar osteitis, is one of the few common complications occurring after dental extraction wherein, sharp shooting pain, disintegrated clot formation, and delayed healing is observed. Despite extensive research, an optimal standardized treatment remains elusive owing to its multifactorial etiology such as, traumatic extractions, clot dislodgement, tobacco use, and microbial activity. A comparative analysis of 15 clinical studies was conducted to gauge the efficacy of different modalities with respect to pain relief and wound healing. This review aims to explore the different management techniques, ranging from traditional and conventional approaches such as honey/turmeric application, medicated dressings with eugenol to emerging regenerative treatments like low-level laser therapy and platelet-rich fibrin.

KEY WORDS: Dental extractions, Alveolar osteitis, Dry socket, Socket healing, Post extraction complications

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INTRODUCTION:

After tooth extraction, formation of a stable blood clot in the socket is important for healing. Some of the most common complications occurring post extraction is Localized alveolitis, also commonly called Localized Alveolar Osteitis or Fibrinolytic Alveolitis or simply Dry Socket[1]. Blum has described it as "post-operative pain in and around the extraction site, which increases in severity at any time between one and three days after the extraction, accompanied by a partially or totally disintegrated blood clot within the alveolar socket, with or without halitosis" [2].

In addition to accumulation of debris and a disintegrating clot in the newly removed socket, which may or may not result in malodour, the patient with dry socket suffers from excruciating throbbing pain[3]. Following regular dental extractions, the chances of occurrence of dry socket is between 1 and 4% [4,5], although it can increase to 30% when impacted mandibular third molars are surgically removed[5,6].

There are multiple possible etiological factors leading to dry socket. One of it may be the early dislodgment of blood clot from extraction site, traumatic surgical extractions, secondary infections, mechanical dislodgement of clot due to patient negligence or ignorance, decreased vascularity in the area,tobacco use and consuming oral contraceptive pills[3]. Increased local fibrinolysis at the socket is another possible reason for alveolar osteitis[7].

Birn, considered that "the trauma resulting from extraction, as well as aggressive curettage, might harm the alveolar bone cells, leading to inflammation of the alveolar osseous medulla and release of cell mediators to the alveolus, where they cause fibrinolytic activity, increasing the risk of dry socket"[8].

An association between the etiology of Alveolar Osteitis and the presence of aerobic bacteria was suggested by Nitzan et al. in 1978. Additionally,

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they noted that cultures of anaerobic Treponema-denticola, a pioneering bacterial species implicated in a number of periodontal disorders, exhibited strong fibrinolytic activity[9].

Dueto its complex etiology and lack of understanding, a variety of therapeutic modalities have been linked by dental professionals for the management of dry socket, with differing degrees of efficacy. Dry socket therapy has never proven effective to date, and patients experience discomfort and a slow rate of healing from socket wounds. The treatment of dry socket is not standardized, and many dental clinics frequently omit its preventive guidelines[10].

Managing dry socket aims to alleviate pain and promote healing[11]. Treatment modalities range from conservative to more interventional approaches. Initial management often involves irrigating the affected socket to remove debris and applying medicaments containing pain-relieving agents like eugenol or local anesthetics[11,12].

If pain persists, stronger analgesics may be prescribed. More recently, laser therapy has surfaced as a prospective cure, aiming to stimulate healing and reduce inflammation[10]. Platelet-rich plasma (PRP) application, which utilizes the patient's own growth factors, is another emerging technique that may accelerate tissue regeneration and reduce healing time[13]. The severity and the clinician's assessment usually determineafavorable treatment option to cure dry socket.

Despite being one of the most prevalent and well-known post-extraction challenges, dry socket, with a history spanning almost a century, a definitive standardization for its treatment is still lacking. Therefore, this review aims to compare the various modalities used in treating dry socket and provide clinicians with a comprehensive overview of these approaches for more favorable and efficient management of this condition.

Search strategy-

Using internet databases like PubMed, Scopus, Web of Science, and Google Scholar, a comprehensive literature search was conducted to locate pertinent papers on the management of dry socket. The articles published between 2014 and 2025 were the focus of the search. The following Boolean operators and keywords were applied:

"dry socket treatment", "alveolar osteitis management", "zinc oxide eugenol" ,"Alvogyl" , "low-level laser therapy", "platelet-rich fibrin", "dry socket pain management" and "healing outcomes".

Inclusion and Exclusion Criteria-

Inclusion criteria:

- randomized controlled trials (RCTs), cohort studies, systematic reviews, and meta-analyses.
- articles that compare two or more dry socket treatment options.
- Articles written in English from peer- reviewed journals.
- studies focused on the clinical efficacy, healing duration, and pain alleviation of various therapies.

Exclusion criteria:

- Case reports, expert opinions, and editorials.
- Studies involving patients with systemic conditions affecting wound healing (e.g., diabetes, immunosuppression).
- Non-English publications without accessible translations.

Study Selection and Data Extraction

The initial database search yielded 325 articles, which were searched for relevance based on titles and abstracts. After application of inclusion and exclusion criteria, 15 studies were selected for full-text review and comparative analysis. The extracted data included:

- Treatment modalities compared (e.g., ZOE, Alvogyl, PRF, LLLT, herbal remedies).
- Pain relief outcomes (measured using pain scales such as VAS).
- Healing duration and formation of granulation tissue.
- Advantages and disadvantages of each method.

DISCUSSION:

Dry socket, also termed as Alveolar osteitis is a painful condition seen 3-4 days after a dental extraction. It is a prevalent post operative complication of this surgical procedure often due to a multiplefactors. The etiology of dry socket is complex and multifaceted with leading causes like dislodgement of blood clot, traumatic extraction, lack of postoperative care, tobacco smoking, poor oral hygiene, use of oral contraceptives pills and even nutritional deficiencies.

Dry socket appears as an empty wound with disintegrated blood clot, debris and exposed bone. It may have a purulent sloughing along with putrid odour. Patients show extreme radiating pain and discomfort

with the site being tender on touch, warm and erythematous. Some may even show localized lymphadenopathy, trismus and swelling.[3,4]

As the saying goes, "Prevention is better than cure", preventing dry socket should be the priority. This can be done so by avoiding vigorous rinsing, forceful spitting, tobacco smoking and practicing good oral hygiene habits. Patients must be sensitized with post operative care protocol. Suturing the wound, prescribing antibiotics, analgesic and anti-inflammatory can help improve the condition.

As it is a very common condition occurring in the dental practice, several conventional and modern treatment strategies and approaches have been explored for a better prognosis of this condition. Treatment aims to alleviate pain and swelling, promote healing of the site and prevent secondary infections which can be a breeding ground for further decay. Conventional approaches include irrigation of the socket, application of a medicated Zinc oxide eugenol dressing or Alvogyl. Herbal remedies like honey and turmeric have gained popularity for its anti-inflammatory properties. Newer modalities like Platelet rich fibrin (PRF), Low level laser therapy (LLLT) and Concentrated growth factor (CGF).

The aim of this literature review revolves around providing an efficient and comfortable solution to a problem which occurs day to day in a dental clinic. From traditional methods like using turmeric and honey to conventional modalities like applying ZOE and Alvogyl dressings to newer regenerative techniques like PRF, CGF and LLLT, numerous studies have been done to deduce the absolute solution to cure dry socket.

Based on the findings from the reviewed studies, these treatment modalities have been assessed for their efficacy in pain relief and healing. 'Alvogyl has demonstrated effectiveness in providing immediate pain relief", as observed in studies by Faizel et al.[14] and Supe et al[15]. However, Neocone was found to offer the fastest healing and long-term pain relief[14]. Ozone-infused olive oil, studied by Khan et al. (2015) [16], showed quicker pain relief compared to Alvogyl. LLLT was found to be more effective than Alvogyl for sustained pain reduction' in few studues[17,18,19]. The use of turmeric and mustard oil as a dressing significantly improved healing outcomes compared to zinc oxide eugenol (ZOE), as demonstrated by Lone et al[20].

Honey also exhibited strong anti-inflammatory properties and enhanced granulation tissue formation (Ansari et al.; Khan et al)[21,22].

"Antibiotic irrigation with clindamycin was found to be more effective than saline or rifampicin for reducing pain in 1 study[23]. Photobiomodulation therapy, studied by Shatha S, et al, improved healing outcomes when combined with Alvogyl.[24]

Advanced regenerative approaches such as concentrated growth factor (CGF) (Kamal et al)[19] and platelet-rich fibrin (PRF) (Bibi et al) [25] accelerated healing and reduced post-operative pain. Finally, re-establishing a blood clot in the socket was found to be more effective than ZOE dressing for pain control and patient satisfaction (Manzooret al)[26]. While conventional treatments like Alvogyl and ZOE remain commonly used, emerging therapies such as PRF, CGF, and laser therapy show promise in improving patient outcomes. Further clinical trials are necessary to establish standardized treatment protocols for optimal dry socket management.

Table 1. A summarized review of the methods, results and conclusion of all the 15 shortlisted articles in a structured format. Table 2. An insight on the advantages and disadvantages of the materials mentioned in the stated studies.

CONCLUSION:

Dry socket remains a challenging post-extraction complication, with no universally accepted treatment protocol. This review highlights the comparative effectiveness of various management approaches, ranging from conventional methods like ZOE and Alvogyl to more advanced techniques such as CGF, LLLT and PRF.

While traditional treatments provide symptomatic relief, newer regenerative therapies show promising results in accelerating healing and reducing pain. Herbal remedies like turmeric and honey have also demonstrated efficacy, offering alternative approaches with minimal side effects. Given the variability in treatment outcomes, further large-scale clinical trials are needed to establish standardized guidelines for optimal dry socket management. A multidisciplinary approach integrating both conventional and modern techniques may offer the best patient outcomes in the future.

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Table 1: Summary of studies and the treatment modality used for resolving dry socket in a healthy patient.

S no.	Title of study/Author/Year	Type of study	Number of patients	Methodology	Results/conclusion of the study
1.	Comparison Between Neocone, Alvogyl and Zinc Oxide Eugenol (ZOE) Packing for the Treatment of Dry Socket: A Double Blind Randomised Control Trial. SayedFaizel et al. 2014 [14]	Double blind randomized control trial	105	Patients diagnosed with dry socket were randomly distributed into three groups. 1) Group A- Alvogyl, 2) Group B- Zinc oxide eugenol (ZOE) 3) Group C- Neocone. decreased pain and wound healing was observed and compared up till the 10th day.	Alvogyl provided initial pain relief as compared to Neocone. While Neocone was slow to act first, it proved as the most superior material due to its property of complete pain relief, faster healing, less dressing changes and fewer visits.
2.	Management of dry socket using Ozone gel vs. Alvogyl – prospective clinical trial. AnumRehman Khan et al. 2015 [16]	Prospective clinical trial	10	Ten patients with dry socket were enrolled, five receiving ozone-infused olive oil and five receiving Alvogyl as a control. The ozone oil was administered similarly to Alvogyl, being placed into the socket after irrigation and debridement. Patients were followed up after two days.	Ozone infused olive oil appeared to promote quicker pain relief for dry socket as comparedto Alvogyl.
3.	Comparison of the effect of low level laser therapy with alvogyl on the management of alveolar osteitis. Eshghpour M et al. 2015 [17]	Prospective randomized clinical trial.	60	Sixty patients with alveolar osteitis were randomly split into three groups. 1) Group 1: Alvogyl 2) Group 2: Low-power red laser therapy (660nm, 200mW, 6J per area) for three days. 3) Group 3: Low-power infrared laser therapy (810nm, 200mW, 6J per area) for three days.	Alvogyl provided better immediate pain relief for dry socket than either red or infrared laser therapy. However, on day 2 and throughout day 3, the red (660nm) laser proved more effective than Alvogyl. The infrared (810nm) laser showed some pain reduction but was less effective than both Alvogyl and the red laser at all time points.

S no.	Title of study/Author/Year	Type of study	Number of patients	Methodology	Results/conclusion of the study
4.	Role of turmeric in management of alveolar osteitis (dry socket): A randomized clinical study. PA Lone et al. 2018 [20]	A randomized clinical study	178	One hundred seventy-eight patients with dry socket were selected for the study. 1) Group A received a turmeric and mustard oil dressing, while 2) Group B received a zinc oxide eugenol (ZOE) dressing.	Faster granulation tissue formation showcasing wound healing and relief from pain was observed in patients who were given turmeric (Group A) as a medicament for dry socket.
5.	Efficacy of Alvogyl (Combination of Iodoform + Butylparaminobenzoate) and Zinc Oxide Eugenol for Dry Socket. Supe, Narendra B.; Choudhary, Sneha ,; Yamyar, Sheetal ; Patil, Kuldeep ; Choudhary, Amit Kumar; Kadam, Vishwas2018. [15]	Single-blinded prospective study	50	Fifty people with dry socket were randomly assigned into two treatment groups: 1) Group I: Alvogyl 2) Group II: zinc oxide eugenol dressing.	Alvogyl was a more effective treatment for dry socket than zinc oxide eugenol, leading to faster pain relief and quicker healing.
6.	A Study to Evaluate the Efficacy of Honey in the Management of Dry Socket Ansari, Arsalan; Joshi, Sanjay; Garad, Aarti; Mhatre, Bhupendra; Bagade, Sachin; Jain, Rushika. 2019 [21]]	prospective study	50	Fifty patients diagnosed with dry socket were selected. Honey was used as a medicament over the period of one week.	The honey dressing led to significant reductions in inflammation, hyperemia, and improved mucosal edges, resulting in decreased pain and discomfort. No adverse reactions were observed.. Distance between the mucosal edges had significantly reduced over the duration of this study

S no.	Title of study/Author/Year	Type of study	Number of patients	Methodology	Results/conclusion of the study
7.	Evaluation of the effects of intra-alveolar irrigation with clindamycin, rifampicin and sterile saline in alveolar osteitis treatment Çebi AT. 2020 [23]	Clinical comparative prospective study	54	Fifty-four patients were distributed into three treatment groups . 1) Group A received sterile saline irrigation, 2) Group B received rifampicin irrigation, and 3) Group C received clindamycin irrigation.	Clindamycin irrigation seemed to lessen the pain due to dry socket more effectively than rifampicin or sterile saline irrigation.
8.	The Efficacy of Concentrated Growth (CGF) Factor in the Healing of Alveolar Osteitis: A Clinical Study. Aqsa Kamal et al. 2020 [27]	Longitudinal cohort study	40	Patients were divided in two groups and the healing along with pain relief was observed on the fourth, seventh and fourteenth day. Control group consisted of patients who received the standard treatment protocol for dry socket i.e saline irrigation and curettage. The test group received placement of CGF gel in the socket .	CGF showed superior results when compared to standard treatment in terms of healing and pain reduction.
9.	Management of dry socket with low-level laser therapy. Aqsa Kamal et al.2020[18]	Longitudinal Cohort Study.	45	45 patients with dry socket were studied. 1)Group one received standard dry socket treatment, 2)Group two received low-level laser therapy (LLLT) at 200mW, 6J, continuous wave. Pain and healing were measured at the start, and then four and seven days later.	Low-level laser therapy (LLLT) appears to be more effective than the standard treatment for dry socket, leading to better pain management and faster healing within the span of 7 days .

S no.	Title of study/Author/Year	Type of study	Number of patients	Methodology	Results/conclusion of the study
10.	A Comparative Clinical Study between Concentrated Growth Factor and Low-Level Laser Therapy in the Management of Dry Socket. Aqsa Kamal et al. 2020 [19]	Longitudinal Cohort Study	60	Sixty dry socket patients were assigned to three groups: 1. Group 1- standard treatment (curettage and saline irrigation), 2. Group 2- CGF treatment 3. Group 3- LLLT. Patients were evaluated at baseline, and then on the 4th, 7th, 14th and 21st day for pain, inflammation, tenderness, and granulation tissue.	The group provided with the standard treatment took longer than 7 days to achieve healing stage as compared to CGF and LLLT groups. Comparing CGF and LLLT, the LLLT group displayed a 4-day delay in both granulation tissue formation and pain relief compared to the CGF group.
11.	A Comparative Study to Evaluate the Effect of Honey and Zinc Oxide Eugenol Dressing for the Treatment of Dry Socket: A Double-Blind Randomized Controlled Trial. *Appl. Sci.* Khan, Z.A.; Prabhu, N.; Ahmed, N.; Lal, A.; Issrani, R.; Maqsood, A.; Alam, M.K.; Alanazi, S.; Aljohani, F.M.; Almndel, M.N.; et al. 2021 [22]	Double-blind randomized controlled trial	90	Ninety patients with dry socket were assigned to three groups of 30 each: 1) Group 1 received honey treatment, 2) Group 2 received zinc oxide eugenol, 3) Group 3 served as the control. Pain scores were measured by a verbal rating scale before and after treatment at various time intervals	Both group 1 and 2 reduced immediate pain levels in dry socket patients compared to group 3.
12.	Comparing The Effectiveness Of Chlorhexidine Gel And Metronidazole Gel In Management Of Dry Socket J Jayaindhraeswaran,SenthilNathan ,Arun. 2021 [28]	In vivo, single blind ,randomised control through comparative protective study	30	Thirty participants with alveolar osteitis were divided in two groups of 15. 1) Group 1: chlorhexidine gel 2) Group 2: metronidazole gel. Patients were recalled on the third and seventh day.	Metronidazole gel led to noticeable improvements in mouth opening and reduced swelling compared to chlorhexidine. It was also more efficacious in reducing post-extraction pain.

S no.	Title of study/Author/Year	Type of study	Number of patients	Methodology	Results/conclusion of the study
13.	Photobiomodulation for Managing "Dry Socket": A Randomised Controlled Trial.Shatha S. ALHarthi a, Dena Ali b, NujudZayedAlamry a, Majed K. Alshehri c d, Darshan D. Divakar e f,Munerah S. BinShabaib . 2022.[24]	Randomised control trail	55	Patients with dry socket were randomly divided into 4 groups. 1) Group 1: curettage and saline irrigation 2) Group 2: curettage and Alvogyl dressings changed every 48 hours . 3) Group 3: curettage, Alvogyl, and photobiomodulation therapy (660nm diode laser). 4) Group 4: only photobiomodulation therapy.	In dry socket patients, combining photobiomodulation therapy with curettage and Alvogyl dressing appeared to be more effective for postoperative pain reduction and healing than curettage alone, or curettage with Alvogyl dressing.
14.	Outcome Of Re-Establishment Of Blood Clot And Zinc Oxide Eugenol Dressing For Management Of Dry Socket In Terms Of Pair. Manzoor, S., Khan, M. ., Shakeel, S. ., Ullah, A. ., & Ahmad, T. . 2024 [26]	Cross sectional study	72	Seventy-two patients diagnosed with dry socket were distributed in two groups . One group of 36 patients received standard treatment followed by induced bleeding in the socket. The second group of 36 patients received normal saline irrigation followed by zinc oxide eugenol placement in the socket.	Re-establishing a blood clot proved to be a superior treatment option compared to zinc oxide eugenol dressing for managing dry socket as It resulted in better pain control, fewer required dental visits, greater patient satisfaction, and lower cost.
15.	Effectiveness of Platelet Rich Fibrin in the Management of Pa in and Healing of Dry Socke. HaleemaBibi, ZarnabRizwan, GhinaRizwan, Syed Hamza Zia. 2025[25]	Case report	1	PRF was placed on the exposed bone and secured with sutures. Granulation tissue and pain, with the help of VAS scale was used to assess healing on the 1st, 3rd,7th and 10th day.	There was no pain on the 7th day and socket walls had been covered by the 10th day

S no.	Title of study/Author/Year	Type of study	Number of patients	Methodology	Results/conclusion of the study
16	Comparative evaluation of zinc oxide eugenol versus gelatin sponge soaked in plasma rich in growth factor in the treatment of dry socket Pal, U.S.; Singh, BalendraPrataɟ; Verma, Vikas [29]	Comparative study	45	The subjects were divided into groups of 3 1) Group A was treated with plasma rich in growth factor dipped in gelatin sponge . 2) Group B was treated with zinc oxide eugenol 3) Group C was treated by plain saline irrigation.	Gelatin sponges soaked with plasma rich in growth factor showed much better healing as compared to both group B and C, however in case of pain management after 15 days no significant difference was found between group A and B.
17	Role of Mercurochrome and Chloromycetin in the Management of Dry Socke: A Clinical Study With a New Approacl. Ashok Bansal , Shivani Jain ,Srimathy Arora ,Shipra Gupta [30]	Prospective clinical trial	50	A group of 50 patients diagnosed with dry socket were administered a combination pack of chloromycetin and mercurochrome.	The combination pack led to excellent healing and pain management in most of the patients on the first day itself
18	The Effectiveness of GECB Pastille in Reducing Complications of Dry Socket Syndrome Abbas Haghighat, Rahim BahriNajafi, ostafaBazvand,HamidBadrian, NavidKhalighinejad, HosseinGoroohi [31]	Randomised clinical trial	30	The patients were divided into two groups of 15 each 1. First group was given ZOE dressing 2. And on the second group pastille GECB was used.	The patients administered with GECB pastille exhibited far better results both in case of healing and pain relief as compared to ZOE dressing .

S no.	Title of study/Author/Year	Type of study	Number of patients	Methodology	Results/conclusion of the study
19.	The Efficacy of a Topical Anesthetic Gel in the Relief of Pain Associated With Localized Alveolar Osteitis Corey C. Burgoyne,DMD,* James A. Giglio, DDS, MEd, Sarah E. Reese, BS, Adam P. Sima, MA,§ and Daniel M. Laskin , DDS, MS [32]	Prospective randomized clinical study	35	The patients were divided into a control group and test group. 1. The control group received the standard treatment which is ZOE with gauge. 2. The test group received a gel composed of 2.5% lidocaine and 2.5% prilocaine	The patients in the test groups reported better pain control as compared to the control group.
20.	Comparison of Alvogyl, SaliCept Patch, and Low-Level Laser Therapy in the Management of Alveolar OsteitisGökselSümsek Kaya, DDS, PhD, GünayYapici, ZeynepSava, andMetinGüngörmüş, [33]	Randomized Prospective clinical trial	104	Randomly assigned 4 groups: Group 1: Curettage and irrigation Group 2: Curettage and irrigation followed by Alvogyl Group 3: Curettage and irrigation followed by a SaliCept patch Group 4: Curettage and irrigation followed by LLLT	Group 4 had significantly better results as compared to the rest of the groups in terms of pain reduction, decreased halitosis and` healing

Table 2: Focuses on the advantages and disadvantages of each treatment option.

S No.	Method / Material	Advantages	Disadvantages
1	Zinc oxide eugenol	• Cost effective [14] • Easily available [14]	• Delayed healing was seen when compared to Alvogyl[15] and GECB Pastille [31] • When used in excess, can cause necrosis of bone [21] • Needs more dressing replacement [31]
2	Alvogyl	• Fast onset of pain relief [14,17] • Less dressing changes along with faster healing is achieved in comparison to ZOE [15]	• Not a sustainable effect [14]
3	Low level laser therapy	• More effective in alleviating pain as compared to Alvogyl[17] and Salicept Patch [33]. • Socket irrigation is not obligatory [17] • Low pain score and faster healing in comparison of the standard treatment of curettage and saline irrigation [18]. • Anti-inflammatory and analgesic effect [34]. • Safe to use on patient [18] • Precise [18]	• Slow onset [17] • High cost [18] • Causes laser-induced oxidative damage to the cells[35].
4	Turmeric	• Anti- inflammatory • Better at alleviating pain as compared to ZOE [20] • Showed healing at margins • No side effect	• More clinical testing needs to be done.
5	Honey	• Antibacterial • Anti-inflammatory • Antioxidant • Minimum patient discomfort [21] • Helps in a faster recovery • Helps in formation of granulation tissue by shedding of the necrotic tissue[36] • Hygroscopic, hence rendering the bacteria inactive [21] • No side effect	• Less clinical evidence available

S No.	Method / Material	Advantages	Disadvantages
6	Ozone gel	• Antimicrobial [16] • Ozone water is more biocompatible as compared to its gaseous or oil based form [16]	• Antimicrobial effect is transient, hence it needs to be reapplied which would be difficult to do at home [16] • Can only be used through an oil based media as ozone water has a short half life[16]
7	Chlorhexidine gel	• Favourable choice of modality for preventing dry socket in recently extracted sockets for every 12 hours for the next 7 postoperative days, as patients can be given a chlorhexidine gel in place of a mouth rinse [37]	• Can be expensive as compared to a chlorhexidine mouthrinse[37]
8	Metronidazole gel	• Decreased postoperative pain and swelling as compared to Chlorhexidine gel [28]	• Metallic taste • May cause an allergic reaction.
9	Platelet rich fibrin	• Less invasive, cost effective and quicker[25] • Minimises risk of allergies as it is patient's own blood [25] • Accelerates bone regeneration and wound healing as it has a rich supply of growth factors[38] • Less postoperative pain or swelling[25]	
10	Antibiotic irrigation (Clindamycin and Rifampicin)	• Formation of granulation tissue and resolution of clinical symptoms like halitosis and erythema occurs faster than the standard method of irrigation with sterile saline [23] • Removes the need for a systemic dosage of antibiotics [23]	• More detailed and long term research is necessary to affirm the role of topical antibiotics in alveolar osteitis. [23]

S No.	Method / Material	Advantages	Disadvantages
11	Concentrated growth factor	• Hastens wound closure and in a short span of time brings down the pain and forms granulation tissue [27]. • Chairside CGF techniques are simple, effective and show favourable treatment outcomes [27]. • Low risk • Cost effective • May require sutures to stabilise the gel within the socket[19] • CGF treated socket generated 75% granulation tissue when compared with LLLT and eliminated any perisocket inflammation or pain symptom within the first week of treatment.[19]	
12	Neocone	• Fastest healing and complete pain relief as compared to Alvogyl and ZOE [14] • Less number of dressing required thus fewer visits [14]	• Slow onset [14]
13	Mercurochrome and Chloromycetin	• No pain experienced by the majority of patients in the first day itself (based on the VAS). [30] • No need for repeating the dressing. [30] • Patients did not require an analgesic along with the dressing [30]	
14	**GECB Pastille**	• Duration of healing was shorter as compared to ZOE.[31] • Analgesic intake was less [31] • Less chair time[31]	• May cause irritation to mucosa
15	**2.5% prilocaine and 2.5% lidocaine gel**	• Pain experienced was less[32] • Antibacterial[39] hence, improves rate of healing. • No need for removal [32] • Comfortable for patient and easier for clinician to use [32]	• May cause hypersensitivity •reaction. • May cause chemical burns.
16	**Sali Cept Patch**	• Helps in wound healing[33]. Helps in increasing blood filtration which further helps in clearing out of pathogens • Enhances immune response by increasing phagocytosis [39] • Antibacterial properties [33] • Antiinflammatory properties. [33] • Cost effective [41]	• More in depth research and clinical trials need to be done to understand the accurate role and functioning of the treatment modality .[40]

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There are no conflicts of interest.

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Short Communication

Minimally Invasive Cosmetic Dentistry: Advance-ments and Scope

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ABSTRACT:

The discipline of dentistry has undergone a profound transformation in recent decades, driven by rapid technological innovation, evolving patient expectations, and a growing societal emphasis on aesthetic enhancement and minimally invasive care. The evolving landscape of cosmetic dentistry reflects a growing emphasis on minimally invasive techniques that prioritize the preservation of natural tooth structure while delivering superior aesthetic outcomes. This article explores recent advancements in minimally invasive cosmetic dentistry, including the integration of laser technology, the rise of clear aligners and lingual orthodontics, and the development of ultrathin ceramic veneers and stratified feldspathic laminates. These innovations have been significantly enhanced by the incorporation of digital dentistry tools such as 3D imaging, CAD/CAM systems, and digital smile design, allowing for improved treatment planning and personalization.

KEY WORDS: minimally invasive dentistry, laser dentistry, CAD/CAM, invisalign, veneers

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INTRODUCTION:

The discipline of dentistry has witnessed a profound transformation over recent decades, shaped by technological innovation, changing societal values, and an increased demand for aesthetic enhancement. Historically, the primary goal of dental care was the prevention and treatment of oral diseases, such as caries and periodontal conditions. However, contemporary dentistry increasingly embraces a dual focus—addressing both oral health and cosmetic concerns.[1]

Cosmetic dentistry, once considered a luxury or adjunct to general dental practice, is now a central component of mainstream dental care. The surge in patient awareness—fueled by social media, celebrity influence, and digital self-representation—has led to a growing demand for procedures that enhance dental appearance, such as teeth whitening, veneers, bonding, contouring, and orthodontic alignments using clear aligners.[2]

Technological advancements have played a pivotal role in this evolution. The adoption of CAD/CAM systems, digital smile design (DSD), laser dentistry, and advanced composite materials has significantly improved the precision, efficiency, and outcome predictability of cosmetic procedures. Furthermore, the incorporation of minimally invasive techniques aligns with patients' desire for natural-looking results with reduced discomfort and recovery time.

Cosmetic dentistry also raises important ethical, psychological, and professional considerations. While many procedures are elective, they can profoundly impact a patient's self-esteem and quality of life.

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PRINCIPLES OF MINIMALLY INVASIVE DENTISTRY:

The core principles of minimally invasive dentistry (MID):

(a) Preserving the natural tooth structure and minimizing the invasive nature of dental interventions
(b) Emphasizes the use of the least invasive methods
(c) Reduction in postoperative discomfort, morbidity, and the risk of soft and hard tissue complications.

Advancements in dental technology, particularly in the realm of digital dentistry, have greatly contributed to the evolution of minimally invasive cosmetic dentistry. The use of digital imaging, computer-aided design and manufacturing (CAD/CAM), and 3D printing have revolutionized the way dentists approach aesthetic restorations.

Examples:

(a) Use of micro-veneers, which are thin, minimally invasive ceramic restorations that can be used to improve the appearance of discolored, or slightly misaligned teeth.
(b) Ceramic veneers, have gained popularity due to their biocompatibility, durability, and the ability to achieve natural-looking results with minimal tooth preparation[3].
(c) Enamel micro-abrasion involves the controlled removal of a thin layer of enamel to improve the appearance of discolored or stained teeth and can be used in conjunction with other cosmetic treatments, such as bleaching.
(d) Resin infiltration technology, on the other hand, is a non-invasive approach that involves the infiltration of a light-cured resin into the porous structure of the enamel, effectively masking and enhancing the appearance of white spot lesions or early-stage caries.

In addition to the advancements in digital dentistry, the field of laser dentistry has also made significant strides in the realm of minimally invasive cosmetic dentistry. Key benefits of using lasers in cosmetic dentistry:

(a) Ability to perform precise and controlled removal of tooth structure, allowing for minimally invasive treatment approaches.
(b) Use of lasers in gum recontouring is another area where minimally invasive techniques have been employed, enabling dentists to reshape and improve the aesthetics of the gingival tissues.
© Lasers have been utilized in the treatment of dental hypersensitivity. By precisely targeting and sealing dentinal tubules, lasers can provide a minimally invasive solution to reduce sensitivity, enhancing the overall aesthetic and functional outcomes for patients.

Orthodontic advancements have also played a significant role in the evolution of MID. The development of clear aligners, such as Invisalign, has revolutionized the field by providing a discreet and comfortable option for straightening teeth. These removable aligners allow for targeted tooth movement without the need for traditional fixed orthodontic appliances, minimizing the impact on the patient's appearance during treatment. Furthermore, the use of 3D imaging and computer-aided design has enabled more precise treatment planning and customisation of aligners, leading to enhanced aesthetic outcomes.

In addition, the introduction of lingual orthodontics, where braces are placed on the inner surface of the teeth, has become a popular choice for patients seeking a discreet approach to straightening.

CONCEPT-

The concept of minimally invasive dentistry (MID) is well-established in contemporary dental literature, emphasizing the preservation of healthy tooth structure through conservative treatment approaches. Among the various minimally invasive treatment modalities, laminated veneers fabricated from stratified feldspathic ceramics have gained prominence[4]. Owing to their biomimetic properties and superior optical characteristics, feldspathic ceramic veneers are particularly suitable for cases demanding high aesthetic outcomes with minimal enamel reduction.

Furthermore, recent advancements in adhesive technology and ceramic materials have facilitated the development of ultrathin ceramic laminate veneers, which offer a minimally invasive alternative for enhancing the aesthetics of anterior dentition. These restorations, often requiring little to no tooth preparation, enable bonding exclusively to the enamel surface—thereby maximizing bond strength and promoting long-term clinical success. Clinical studies have demonstrated favorable outcomes in terms of

color stability, marginal adaptation, and longevity when enamel bonding is maintained[5].

SUMMARIZATION OF USES:

(a) Minimally invasive cosmetic dentistry have been significantly influenced by the integration of novel technologies and materials aimed at preserving tooth structure while achieving superior aesthetic outcomes.

(b) Laser technology are widely utilized in procedures such as teeth whitening, gingival recontouring, and the management of dental hypersensitivity.

(c) Innovations in orthodontics- The introduction of clear aligner systems such as Invisalign, as well as lingual orthodontic appliances.

(d) The integration of digital imaging, CAD/CAM technology, and 3D printing has further refined orthodontic diagnostics and treatment planning, allowing for precise customization of aligners and more predictable aesthetic results[6].

(e) Laminated veneers made from stratified feldspathic ceramics and ultrathin ceramic laminate veneers represent a cornerstone of minimally invasive aesthetic treatment. These modalities enable enhancement of tooth morphology and shade with minimal to no enamel reduction[4].

CONCLUSION:

In conclusion, the field of minimally invasive cosmetic dentistry has undergone remarkable advancements, driven by the continuous development of materials, techniques, and digital technologies. The use of lasers has enabled precise and controlled removal of tooth structure, allowing for more conservative treatment approaches. Orthodontic advancements, such as clear aligners and lingual orthodontics, have provided discreet and comfortable options for straightening teeth. The integration of digital dentistry and 3D imaging has further enhanced treatment planning and customisation, leading to improved aesthetic results. As the field continues to evolve, it is expected that further innovations in orthodontic technologies and minimally invasive techniques will cater to the growing demand for more aesthetic and patient-friendly treatment options, ultimately improving the overall quality of care and satisfaction for patients seeking cosmetic dental enhancements.

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Conflicts of Interest

There are no conflicts of interest.

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Case Report

Unresponsiveness Does Not Always Indicate A Conversion Episode - A Unique Case Report

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ABSTRACT:

This case report discusses a 22-year-old male presenting with multiple episodes of unresponsiveness, excessive daytime sleepiness, and disturbed nocturnal sleep over the past 1.5 years. Initially suspected to have a seizure disorder by neurologist, the patient's investigations were normal, leading to a referral for psychiatric evaluation in view of functional neurological symptom disorder (conversion disorder). On detailed history taking and examination in psychiatry out-patient department, patient was instead found to be suffering from narcolepsy with cataplexy (Type 1). Patient showed significant improvement in symptoms, including cessation of cataplexy and improved sleep patterns, on treatment with methylphenidate. This case highlights the importance of history taking and examination for accurate diagnosis and effective management of sleep-wake disorders like narcolepsy which often get undiagnosed in out-patient department settings.

KEY WORDS: Narcolepsy, Cataplexy, Functional Neurological Symptom Disorder, Sleepiness, Diagnosis

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INTRODUCTION:

Patients presenting with unresponsive episodes undergo evaluation focusing on seizure disorders or psychiatric conditions.[1] However, sleep-wake disorders like narcolepsy, characterized by excessive daytime sleepiness, sleep paralysis, and cataplexy, can be mistaken for psychiatric condition [2], making detailed history taking and clinical examination crucial.

The misdiagnosis of sleep-wake disorders like narcolepsy subject patients to unnecessary treatments. Role of multi-modal diagnostic approach, like polysomnography, is necessary for accurate diagnosis [3, 4, 5]. It is vital for specialists in neurology, psychiatry, and general medicine to work together to ensure that patients receive the correct diagnosis and treatment, avoiding unnecessary delays and mismanagement.

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CASE REPORT:

A 22-year-old male presented to the psychiatry outpatient department with complaints of multiple unresponsive episodes, excessive daytime sleepiness, and disturbed nocturnal sleep, persisting for the past 1.5 years. The episodes had a gradual onset and a progressive course, where the patient experienced sudden falls primarily triggered by yawning (Figure 1). These episodes were marked by bilateral tone loss in the lower extremities, which eventually progressed to generalized tone loss. Each episode lasted a few minutes, occurring 15-20 times a day, during which the patient was unable to move and occasionally fell asleep. Importantly, there was no confusion post-episode, and the patient regained control of his body after a short period.

The patient was suspected of having a seizure disorder by a neurologist, and was on a regimen

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Figure 1: Episode of fall/unresponsiveness in patient.

consisting of Valproate 400mg BD, Armodafinil 50mg 1-1-0, and Melatonin 5mg at 8 PM for the past 1.5 months. Although there was some improvement in daytime sleepiness, the unresponsive episodes showed no significant improvement with the prescribed treatment. The EEG & MRI brain revealed no abnormal findings. Notably, the patient had no previous psychiatric history or significant medical conditions requiring hospitalization, and there was no history of substance use in the patient or his family members. Given the lack of positive findings in the neurological investigations, the patient was referred for psychiatric evaluation, suspecting a functional neurological symptom disorder (conversion disorder).

The psychiatric evaluation consisted of detailed history taking from the patient and family members along with clinical examination. The diagnosis was eventually revised to Type 1 Narcolepsy (as per the DSM-5 diagnostic criteria). Unresponsive episodes were confirmed to be cataplexy, which is a sudden loss of muscle strength triggered by strong emotions, such as laughter or yawning. The presence of excessive daytime sleepiness, sleep paralysis pointed toward Narcolepsy. Cataplexy was identified as the primary manifestation, which was misinterpreted as conversion disorder due to the patient's sleepiness and loss of muscle tone during episodes. Patient's BMI was 24.82 kg/m².

He was treated with Methylphenidate, starting at 10mg and increasing to 20mg after 5 days. Initially, the patient had significant daytime sleepiness (ESS score 16/24) but with treatment, symptoms improved: cataplexy episodes ceased, sleep paralysis resolved, nocturnal sleep improved, and daytime sleepiness decreased (ESS score 12/24). The patient remained on Methylphenidate 20mg with regular follow-ups, and symptoms remained well-controlled, allowing him to resume daily activities without further episodes of cataplexy.

DISCUSSION:

This case highlights the importance of history taking and clinical examination to diagnose often-overlooked sleep-wake disorders, particularly narcolepsy, which can present with fall/unresponsive episodes. The diagnosis is often confused with functional neurological symptom disorder (conversion disorder) or pseudoseizures, as revealed by Atassi et al who emphasized the importance of differentiating between cataplexy and pseudoseizures, especially in patients with unresponsive episodes and no clear evidence of epilepsy or other neurological disorders, to avoid delayed treatment and prolonged suffering.[1]

The International Classification of Diseases, Eleventh Revision (ICD-11) (WHO, 2021) further categorizes sleep-wake disorders as a separate chapter, distinguishing them from psychiatric disorders, as opposed to earlier classifications, like the ICD-10 (WHO, 1993), which placed them under mental and behavioral disorders. This change may lead to non-referral to psychiatrist, thus missing diagnosis of sleep-wake disorders.[2,3]

Moreover, the DSM-5 (American Psychiatric Association, 2022) diagnostic criteria for Narcolepsy with Cataplexy emphasize the presence of excessive daytime sleepiness, sudden muscle weakness (cataplexy), and other sleep disturbances. This is in contrast to conversion disorder, which is primarily characterized by neurological symptoms that do not have a clear medical cause, often triggered by psychological stress. In the presented case, while the episodes were initially suspected to be pseudoseizures, the careful diagnostic approach led to the discovery of narcolepsy, which has distinct diagnostic criteria that should be differentiated from psychiatric conditions like conversion disorder.[4]

The importance of utilizing tools like the Epworth Sleepiness Scale (ESS) (Murray W. Johns, 1991) in diagnosing narcolepsy cannot be overstated. The patient's initial ESS score of 16/24 indicated significant daytime sleepiness, a hallmark of narcolepsy. By tracking changes in the ESS score over time, clinicians can better assess the severity of the condition and evaluate the effectiveness of treatment. In our case, the patient's ESS score improved to 12/24, reflecting a reduction in excessive daytime sleepiness

following appropriate treatment with Methylphenidate, which targets both sleepiness and cataplexy.[5]

However, it is important to note the limitations in diagnostic tools available in many settings, such as Polysomnography and CSF Hypocretin levels, which are not readily available in many Indian institutions, including the author's institute. The lack of these diagnostic modalities can hinder a comprehensive diagnostic approach to narcolepsy, as they are essential for confirming the diagnosis. Polysomnography helps in differentiating narcolepsy from other sleep disorders, while CSF hypocretin levels are a definitive test for narcolepsy. This underscores the need for improved access to diagnostic resources in tertiary care settings to facilitate a more accurate and timely diagnosis.

CONCLUSION:

This case illustrates the importance of history taking and clinical examination in diagnosing sleep-wake disorders, emphasising that not all unresponsive episodes are indicative of conversion disorder. Narcolepsy with Cataplexy can present with episodes of muscle weakness or paralysis that might be misinterpreted as conversion disorder due to their triggering factors (e.g., yawning, emotions). The correct diagnosis of Type 1 Narcolepsy with Cataplexy enabled appropriate treatment, leading to significant improvement in the patient's quality of life.

DECLARATION OF PATIENT CONSENT:

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of Interest

There are no conflicts of interest.

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Case Report

Clenched Cues: Unraveling the Overlap of Bruxism and Restless Leg Syndrome without Polysomnography- A Case Report

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ABSTRACT:

Sleep disorders are a prevalent and complex group of conditions that disrupt normal sleep patterns, significantly impacting overall health, safety, and quality of life. Sleep disorders can occur as primary disorder or in combination with other psychiatric disorders or sleep disorders. This case report presents a 40-year-old male with a complex set of symptoms characterized by bruxism and restless legs syndrome (RLS). A therapeutic trial was successful but challenges in diagnosing still persisted. This case highlights the complexities of coexisting sleep disorders and the importance of personalized treatment approaches, emphasizing the need for further research into the treatment of these complex sleep disorders.

KEY WORDS: Sleep disorders, Bruxism, Restless Legs Syndrome, Pramipexole, Coexisting sleep disorders

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INTRODUCTION:

Sleep disorders disrupt normal sleep patterns and are common in medical practice, impacting physical, mental, social, and emotional functioning. Non-restorative sleep, such as insomnia, significantly impairs functioning.A study highlighted the substantial impairment in quality of life in patients with insomnia, underscoring the importance of addressing sleep disorders.[1] The International Classification of Sleep Disorders provides a framework for classification. Bruxism, a parasomnia, involves teeth clenching or grinding during sleep and can be tonic, phasic, or combined.[2] Its unclear etiology complicates diagnosis.[3] Restless Leg Syndrome (RLS), a dyssomnia, causes unpleasant leg sensations and an irresistible urge to move the legs before sleep. Coexisting sleep disorders, like bruxism and RLS, present diagnostic challenges, highlighting their complex interactions.

CASE REPORT:

A 40-year-old male presented to the department of Psychiatry with a complex set of symptoms eight months duration. His primary complaint was the sensation of clenching of teeth while falling asleep, which was accompanied by pain in the jaw and around the temporomandibular joint, particularly in the morning. Additionally, he experienced a stretching sensation in his arms at rest, predominantly at night. Notably, the patient had a history of RLS that had resolved on its own a year prior to his presentation.

Upon mental status examination, the patient was found to be grossly normal, with an anxious affect. This suggested that his symptoms were not solely related to a psychiatric condition, but rather a complex interplay of neurological and sleep-related factors.

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Table 1: Assessment of diagnosis

	Points favouring diagnosis	Points against diagnosis
BRUXISM	• Experiencing jaw pain in morning • Clenching felt while in deep sleep	• Unusual presentation (clenching, commonly presents as grinding) • Teeth guard exacerbated symptoms • Response to therapeutic trial
FACE VARIANT OF RLS	• Arm variant of RLS at night • h/o RLS in past	• Jaw pain experienced in morning after waking up • No difficulty in sleep initiation

Given the patient's unique set of symptoms, a therapeutic trial was given. He was started on pregabalin 50 mg. Later, pramipexole 0.125 mg was added to his treatment regimen on follow up.

On serial follow-ups, the patient reported significant improvement in his bruxism symptoms, characterized by reduced teeth clenching, as well as a decrease in arm restlessness. However, he continued to experience difficulties with deep sleep and reported having nightmares off and on. This suggested that while the treatment regimen was effective in managing some of his symptoms, further adjustments may be necessary to fully address his sleep-related issues.

The treatment of bruxism is challenging, and there is limited evidence to support the use of certain medications, such as clonazepam, clonidine, and pramipexole. However, in this case, the patient responded well to a therapeutic trial of pregabalin and pramipexole, suggesting that this combination may be a viable treatment option for some patients with bruxism and face variant of RLS.

DISCUSSION:

This case presented a diagnostic challenge due to the presence of multiple possible differential diagnoses, including a facial variant of RLS, bruxism, seizure disorder, and somatic symptom disorder. Table 1 explains the diagnostic dilemma faced while managing the given case. Although the patient responded positively to treatment, uncertainty around the exact diagnosis persisted. Pramipexole, a dopamine agonist commonly used in RLS, is known to disrupt sleep in the early stages of treatment.[4] The patient initially experienced worsened sleep after starting pramipexole, but over time reported a marked improvement in bruxism. This seemingly contradictory response added to the diagnostic complexity. While the clinical features suggested bruxism, the therapeutic response to a medication typically used for RLS raised the possibility of an underlying RLS component, making it difficult to establish a single definitive diagnosis. Unlike many medical conditions where visible signs help in diagnosis, sleep disorders often depend heavily on the patient's subjective experience. Objective tests like polysomnography (PSG) are valuable, but not always accessible. In this case, despite the unavailability of PSG, careful history-taking revealed overlapping symptoms of bruxism and arm restlessness, suggesting a comorbid presentation rather than a single isolated condition.

Research supports the possibility of such overlap.[3-5] A Canadian study by Lavigne GJ et al,found that a notable proportion of people with RLS also experienced symptoms of sleep bruxism.[5] Similarly, a study by Dickoff D reported that over 40% of RLS patients had a history of bruxism, and among those treated with dopamine agonists, a significant number showed improvement in both RLS and bruxism symptoms.[6]

Current clinical guidelines for managing RLS, developed by the International Restless Legs Syndrome Study Group, recommend medications such as pregabalin, ropinirole, pramipexole, and rotigotine.[7] Iron supplementation is also advised for patients with low ferritin levels, as iron deficiency can exacerbate symptoms.[8]

In this case, the patient was initially treated with pregabalin 50 mg, followed by the addition of pramipexole 0.125 mg during follow-up. This combination resulted in significant relief from both bruxism and arm restlessness, supporting the possibility of an RLS variant with overlapping features.

Sleep disorders are a crucial but often under-recognised area within psychiatry. The recent ICD-11 classification removed sleep disorders from the domain of psychiatric diagnoses, which may inadvertently delay timely recognition and management—especially when these disorders present in unusual or complex ways. This highlights the need for better training of mental health professionals in recognising sleep-related issues. A holistic, multidisciplinary approach is essential when evaluating sleep complaints,

particularly given how frequently they co-occur with other physical or psychological conditions.[6]

CONCLUSION:

This case throws the light on the diagnostic complexity and therapeutic challenges associated with bruxism presenting as a facial variant of RLS. Effective management requires a comprehensive approach, encompassing detailed clinical evaluation and therapeutic trials. Given the rarity of this presentation, further research is warranted to better understand its underlying pathophysiology and to establish evidence-based treatment strategies. In settings where advanced investigations such as PSG are unavailable, clinicians can still achieve accurate diagnosis and effective treatment through meticulous history-taking and a committed, holistic approach. This case reinforces the value of clinical acumen and the psychiatrist's role in managing atypical and under recognized conditions.

DECLARATION OF PATIENT CONSENT:

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of Interest

There are no conflicts of interest.

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Case Report

When Functional Neurological Symptom Disorder Isn't Functional: A Case Report of Basal Ganglia Infarct Mimicking Psychiatric Illness

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ABSTRACT:

Functional neurological symptom disorder, also known as "conversion disorder," is a common source of disability in medicine. Patients have often been misdiagnosed, correctly diagnosed after lengthy delays, and/or subjected to poorly delivered diagnoses that prevent diagnostic understanding and lead to inappropriate treatments, iatrogenic harm, unnecessary and costly evaluations, and poor outcomes.

A 45-year-old female presented with sudden onset muteness, generalized weakness, and excessive daytime somnolence, initially suggesting a diagnosis of conversion disorder. However, an MRI scan revealed an acute infarct in the right basal ganglia and a small infarct in the left gangliocapsular region, indicating a vascular infarct as the underlying cause. This case highlights the importance of considering neurological examination in patients presenting with unusual symptoms, duration, and treatment response, to avoid misdiagnosis and provide accurate treatment. It also emphasizes the complex interplay between psychological and neurological factors in patients presenting with unusual symptoms.

KEY WORDS: Conversion disorder; Basal ganglia infarct; Stroke mimics

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INTRODUCTION:

Conversion disorder consists of neurological symptoms affecting sensory or motor function that are inconsistent with known neurological/medical conditions. These symptoms typically appear suddenly and may include coordination, balance, cognitive deficits, or postural abnormalities. The onset, exacerbation, or maintenance of symptoms are commonly attributed to mental factors, such as stress or trauma in a general sense. The disorder tends to appear between late childhood and early adulthood and is more common among women.[1,2] Though sudden-onset behavioral symptoms following clear precipitating events suggest psychiatric diagnoses, striatal lesions can manifest with aphasia, apathy, and flat affect—mimicking psychiatric conditions. Thorough neurological assessment remains crucial for accurate diagnosis despite apparent psychiatric presentation.

CASE REPORT:

A 45-year-old diabetic female from a rural background presented to our hospital with a distinctive clinical presentation characterized by symptoms that were abrupt in onset and showed progressive worsening over time. She had been under significant stress due to her participation in local political activities. Family members reported that immediately before her symptoms appeared, she received disturbing news that police might raid her home for alleged election misconduct.

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Family reported that after receiving distressing news during her local campaign activities, she became abruptly mute and unresponsive, stopped engaging in conversation or household tasks, and displayed increased sleep patterns. Despite these symptoms, she maintained adequate self-care and grooming.

Two days after symptom onset, the family consulted a local psychiatrist who prescribed risperidone 2mg BID, clonazepam 0.25mg BID, and lorazepam 2mg at bedtime. After four days without improvement, they brought her to our outpatient department with a 6-day history of sudden-onset muteness, generalized weakness, and somnolence.

A general physical and systemic examination revealed no gross abnormalities. Her vital signs were within normal limits: blood pressure 110/70 mmHg, pulse rate 90/min, and oxygen saturation 98% at room air. There was no evidence of pallor, icterus, cyanosis, clubbing, or lymphadenopathy.

A mental status examination revealed that the patient was conscious and cooperative but not communicative. She was well-clad and kempt, covering her head properly according to cultural norms. There were no abnormalities in her gait, posture, or gestures, and eye contact was initiated but not maintained. The patient did not respond to mood assessment, and her affect was blunt. Thought, perception, and cognitive functions could not be assessed due to the patient's lack of communication.

A brief neurological examination revealed no spontaneous abnormal movements or gait abnormalities. Plantars were bilateral mute, and there was no evidence of rigidity or spasticity. Based on history and mental status assessment, acute psychosis and conversion disorder were considered as differentials and therefore was started on escitalopram 5mg twice daily, clonazepam 0.25mg twice daily and if necessary.

Alongwith treatment, the MRI brain was also ordered to rule out neurological causes. The MRI revealed an acute infarct in the right basal ganglia and a small infarct in the left gangliocapsular region (Figure 1), indicating a vascular infarct as the underlying cause of her symptoms.

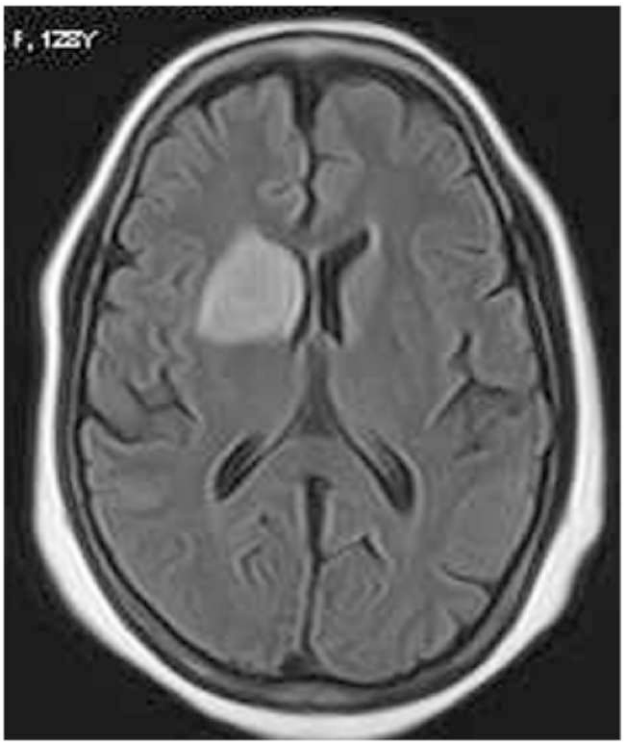

Figure 1: MRI brain showing basal ganglia infarct

DISCUSSION:

This case emphasizes a critical clinical lesson: vascular pathology can convincingly mimic psychiatric presentations. The patient presented with sudden mutism, generalized weakness, and excessive somnolence following election-related stress—a presentation initially attributed to conversion disorder or acute psychosis.

Conversion disorder appeared to be a reasonable working diagnosis, especially considering the temporal relationship with psychological stress. The critical turning point came when neuroimaging revealed right basal ganglia and left gangliocapsular infarcts, lesions known to produce apathy, reduced speech, and flat affect that resemble psychiatric symptoms.[3-5]

This case demonstrates how relying solely on phenomenological diagnosis can lead to misattribution. While affect and behavioral assessment remain valuable clinical tools, they must be supplemented by appropriate neurological examination when presentations are atypical or treatment-resistant. Despite our patient initially having a normal neurological examination, subsequent MRI revealed a basal ganglia infarct. This demonstrates that the assumption that patients presenting to psychiatric services must have purely psychiatric disorders can lead to missed diagnoses. A brief neurological screening examination should be considered standard practice during psychiatric assessment, especially with unusual symptom presentations.

Contrasting our case, Tobiano et al described a young woman with sudden left hemiparesis initially suggesting stroke, but expedited evaluation at a stroke center confirming conversion disorder instead.[6] Conversely, Venturini et al reported a case where an incidental vascular abnormality complicated a

functional neurological disorder diagnosis, explaining some but not all symptoms, which prolonged suffering and generated unnecessary medical costs.[7]

CONCLUSION:

Neurological and psychiatric symptoms frequently overlap, creating diagnostic confusion. Comprehensive neurological assessment, including appropriate neuroimaging, is essential even when psychiatric explanations seem plausible. Clinicians must maintain vigilance for organic pathology, particularly when symptoms are unusual in presentation, duration, or treatment response. This approach ensures accurate diagnosis and optimal patient care, especially in emergency settings where functional diagnoses may be prematurely assigned.

DECLARATION OF PATIENT CONSENT:

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Financial Support and Sponsorship

Nil.

Conflicts of Interest

There are no conflicts of interest.

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Research Article

Assessment of Dental Caries Experience and Treatment Needs Among 12 and 15-Year-Old Schoolchildren in Government and Private Schools of Bhopal City

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ABSTRACT:

Background: Dental caries remains one of the most prevalent chronic conditions among school-aged children. Monitoring caries prevalence and treatment needs at key WHO index ages (12 and 15 years) provides valuable insight for public health planning. The study was aimed to assess and compare the prevalence of dental caries and treatment needs among 12- and 15-year-old children studying in government and private schools in Bhopal city.

Materials & Methods: A cross-sectional study was conducted over 3 months among 730 schoolchildren (12 and 15 years old) selected from government and private schools in Bhopal. Data collection included a visual-tactile dental examination using a dental explorer, based on WHO Dentition Status and Treatment Need criteria (2013).

Results: The mean DMFT score was significantly higher in 15-year-olds (1.69) than in 12-year-olds (1.34) ($p = 0.032$), and in government school children (1.90) compared to private school children (1.20) ($p = 0.001$). Children brushing twice daily had significantly lower caries experience than those brushing occasionally or once daily ($p = 0.005$). Snack consumption between meals was positively associated with higher DMFT scores ($p < 0.001$). Restorative care was the most common treatment need (32.9%), followed by preventive care (26.0%), with government school students showing significantly higher treatment needs across categories.

Conclusion: Regular school-based oral health programs, preventive education, and timely restorative care are essential to address these gaps and improve oral health outcomes among school-aged children in Bhopal.

KEY WORDS: Dental caries, DMFT, government and private schools, oral health, WHO criteria

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INTRODUCTION:

Oral health is widely recognized as a fundamental human right, transcending boundaries of race, religion, political ideology, social standing, or economic status.[1] The interconnectedness of oral and general health was first formally acknowledged in

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1989, with the oral cavity often described as a "window" to overall health.[7] Oral health encompasses more than just the absence of disease; it includes psychosocial well-being, self-confidence, and the ability to perform essential functions such as eating, speaking, and socializing without pain or embarrassment.[3] Throughout life, oral health plays a critical role in enabling individuals to thrive and fully participate in society. However, oral diseases-particularly dental caries-remain a major public health concern globally, especially among children and adolescents, with notable shifts in prevalence patterns over the past two decades.[4,5]

The prevalence of dental caries among schoolchildren in India varies widely, with studies reporting rates ranging from 31.5% to as high as 89% across different regions of the country.[6] Dental caries commonly affect children, largely due to changing dietary habits-particularly increased consumption of refined carbohydrates-and inadequate oral hygiene practices. Although these conditions are prevalent across all socioeconomic groups, they are disproportionately observed among children from lower socioeconomic backgrounds, reflecting persistent oral health inequalities in society. Studies have shown that children from economically disadvantaged families exhibit higher rates of dental caries and gingivitis.[7] The consequences of dental caries extend beyond oral discomfort, causing both acute and chronic pain that can hinder a child's growth, development, school performance, and overall well-being. If left untreated, dental caries can lead to irreversible tooth damage and systemic infection, thereby significantly affecting a child's quality of life.[8]

Schools play a vital role in shaping children's long-term oral health behaviors, as the school years represent a critical window when habits are most easily adopted and retained. According to the World Health Organization (WHO), monitoring dental caries at age 12 is essential because it coincides with the eruption of permanent teeth (excluding third molars), making it a global benchmark for caries surveillance, while age 15 provides insight into the cumulative effects of early adolescent habits.[9,10] The implementation of regular assessments in both government and private schools helps reveal socioeconomic disparities in oral health, enabling targeted interventions. School-based programs such as oral health education, sealant application, and screening have been shown to significantly improve oral hygiene and reduce caries prevalence among students.[11,12] Continuous monitoring at these key ages supports early detection, prevention, and education efforts, ultimately fostering lifelong healthy practices. The aim of thisour study was to assess and compare the prevalence of dental caries among 12 and 15-year-old children studying in government and private schools in Bhopal city.

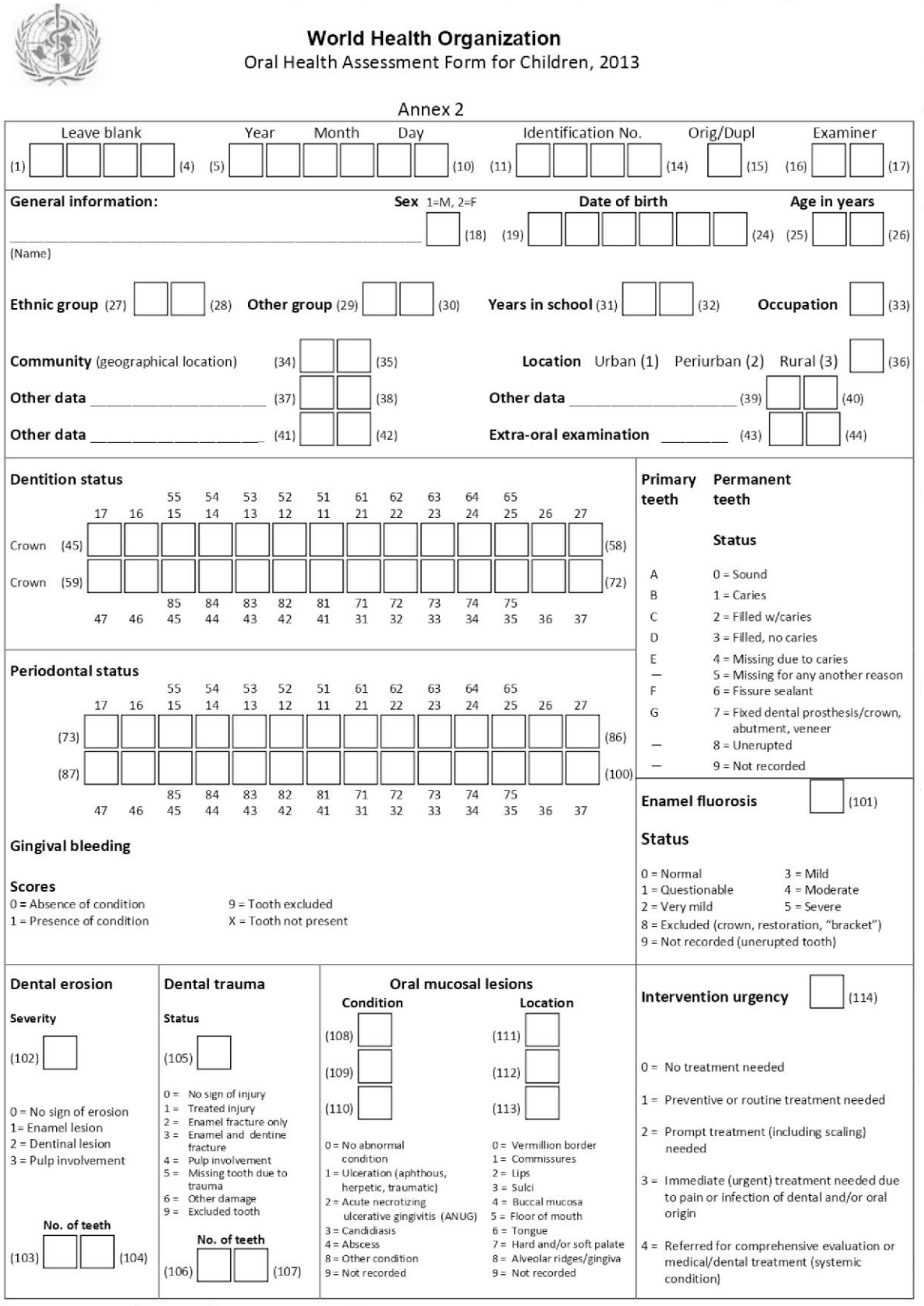
MATERIALS & METHODS:

A cross-sectional study was conducted over a period of three months to assess the prevalence of dental caries among 12- and 15-year-old schoolchildren in Bhopal city. Ethical clearance was obtained from the Institutional Ethics Committee. A total of 730 students were selected using stratified random sampling from both government and private schools, ensuring representation across different socioeconomic backgrounds. Informed consent was obtained from the parents, and permission was granted by school authorities prior to data collection.

Data collection involved two components: a clinical oral examination and a structured questionnaire. The clinical examination was carried out within the school premises under adequate natural light using the visual-tactile method, with a sterile dental explorer and plane mouth mirror. Dental caries status and treatment needs were recorded according to the WHO Oral Health Assessment Form (2013). All examinations adhered to standard infection control protocols (Figure 1).

In addition to clinical data, a pretested questionnaire was administered to collect information on socio-demographic factors such as the child's age, gender, type of school (government or private), and parental education level (Figure 2). Oral hygiene practices were assessed by asking about the frequency of tooth brushing. Dietary habits were evaluated by recording the frequency of consumption of sugary foods and beverages, as well as snacking habits between meals. Courtesy reporting of oral health findings was shared with schools and parents, and children identified with treatment needs were referred to nearby dental care facilities.

The collected data was entered and analyzed using IBM SPSS Statistics software, version 30. Descriptive statistics, including frequency and percentage distributions, were used to summarize categorical variables such as age, gender, type of school, and oral hygiene practices. The mean and standard deviation were calculated for continuous variables like the DMFT scores. An independent *t*-test was used to compare the mean DMFT scores between two groups (e.g., government vs. private schools), while one-way ANOVA was applied to assess differences in mean DMFT scores across more than two categories, such as varying frequencies of snack



World Health Organization
Oral Health Assessment Form for Children, 2013

Annex 2

Leave blank (1) (4) | Year Month Day (5) (10) | Identification No. (11) (14) | Orig/Dupl (15) | Examiner (16) (17)

General information: Sex 1=M, 2=F (18) | Date of birth (19) (24) | Age in years (25) (26)

(Name)

Ethnic group (27) (28) **Other group** (29) (30) **Years in school** (31) (32) **Occupation** (33)

Community (geographical location) (34) (35) **Location** Urban (1) Periurban (2) Rural (3) (36)

Other data (37) (38) **Other data** (39) (40)

Other data (41) (42) **Extra-oral examination** (43) (44)

Dentition status

		17	16	55/15	54/14	53/13	52/12	51/11	61/21	62/22	63/23	64/24	65/25	26	27	
Crown	(45)															(58)
Crown	(59)															(72)
		47	46	85/45	84/44	83/43	82/42	81/41	71/31	72/32	73/33	74/34	75/35	36	37	

Periodontal status

		17	16	55/15	54/14	53/13	52/12	51/11	61/21	62/22	63/23	64/24	65/25	26	27	
	(73)															(86)
	(87)															(100)
		47	46	85/45	84/44	83/43	82/42	81/41	71/31	72/32	73/33	74/34	75/35	36	37	

Gingival bleeding

Scores
0 = Absence of condition
1 = Presence of condition
9 = Tooth excluded
X = Tooth not present

Primary teeth	Permanent teeth
	Status
A	0 = Sound
B	1 = Caries
C	2 = Filled w/caries
D	3 = Filled, no caries
E	4 = Missing due to caries
—	5 = Missing for any another reason
F	6 = Fissure sealant
G	7 = Fixed dental prosthesis/crown, abutment, veneer
—	8 = Unerupted
—	9 = Not recorded

Enamel fluorosis (101)

Status

0 = Normal
1 = Questionable
2 = Very mild
3 = Mild
4 = Moderate
5 = Severe
8 = Excluded (crown, restoration, "bracket")
9 = Not recorded (unerupted tooth)

Dental erosion

Severity (102)

0 = No sign of erosion
1= Enamel lesion
2 = Dentinal lesion
3 = Pulp involvement

No. of teeth (103) (104)

Dental trauma

Status (105)

0 = No sign of injury
1 = Treated injury
2 = Enamel fracture only
3 = Enamel and dentine fracture
4 = Pulp involvement
5 = Missing tooth due to trauma
6 = Other damage
9 = Excluded tooth

No. of teeth (106) (107)

Oral mucosal lesions

Condition (108) (109) (110)

0 = No abnormal condition
1 = Ulceration (aphthous, herpetic, traumatic)
2 = Acute necrotizing ulcerative gingivitis (ANUG)
3 = Candidiasis
4 = Abscess
8 = Other condition
9 = Not recorded

Location (111) (112) (113)

0 = Vermillion border
1 = Commissures
2 = Lips
3 = Sulci
4 = Buccal mucosa
5 = Floor of mouth
6 = Tongue
7 = Hard and/or soft palate
8 = Alveolar ridges/gingiva
9 = Not recorded

Intervention urgency (114)

0 = No treatment needed
1 = Preventive or routine treatment needed
2 = Prompt treatment (including scaling) needed
3 = Immediate (urgent) treatment needed due to pain or infection of dental and/or oral origin
4 = Referred for comprehensive evaluation or medical/dental treatment (systemic condition)

Figure 1: WHO Oral Health Assessment Form.

STUDY PROFORMA

1. General Information

- **Name of the Student**: _____
- **Age**: ☐ 12 years ☐ 15 years
- **Gender**: ☐ Male ☐ Female
- **Type of School**: ☐ Government ☐ Private

2. Oral Hygiene Practices

- **Frequency of Brushing**:
  ☐ Once daily
  ☐ Twice daily
  ☐ Occasionally
- **Type of Oral Hygiene Aid Used**:
  ☐ Toothbrush and toothpaste
  ☐ Finger and toothpaste
  ☐ Others (Specify): _____
- **Use of Fluoridated Toothpaste**:
  ☐ Yes ☐ No ☐ Don't know

3. Dietary Habits

- **Do you consume snacks between meals?**
  ☐ Never
  ☐ Once
  ☐ More than once
- **Type of snacks commonly consumed** (tick all that apply):
  ☐ Chocolates/sweets
  ☐ Chips/fried snacks
  ☐ Soft drinks
  ☐ Biscuits
  ☐ Fruits
  ☐ Others (specify): _____

Examiner's Name & Signature: _____
Date of Examination: ____ / ____ / _____
Let me know if you would like to include an oral hygiene index (like OHI-S) or SES details.

Figure 2: Pretested questionnaire.

consumption. A *p*-value of <0.05 was considered statistically significant.

RESULTS:

The analysis revealed important patterns in the distribution and determinants of dental caries among school children. The study included a total of 730 participants, with a nearly equal distribution of males (51.4%) and females (48.6%), and no statistically significant difference in gender distribution (p=0.284) (Figure 3).

The mean DMFT score was significantly higher in 15-year-olds (1.69) compared to 12-year-olds (1.34), indicating that caries experience increases with age (p=0.032). Males had a higher caries experience (1.71) mean DMFT than females (1.38), with a significant difference (p=0.048). A notable disparity was observed between school types—government school students had a significantly higher mean DMFT (1.90) than those in private schools (1.20) (p=0.001), suggesting socioeconomic influences on oral health. Brushing frequency was significantly associated with caries levels (p=0.005); children brushing twice daily had lower mean DMFT scores (1.10), while those brushing occasionally or never had the highest mean DMFT scores (2.40) (Table 1). Additionally, frequent snacking between meals was linked to increased caries experience, with a statistically significant difference among groups (p=0.001) (Table 2).

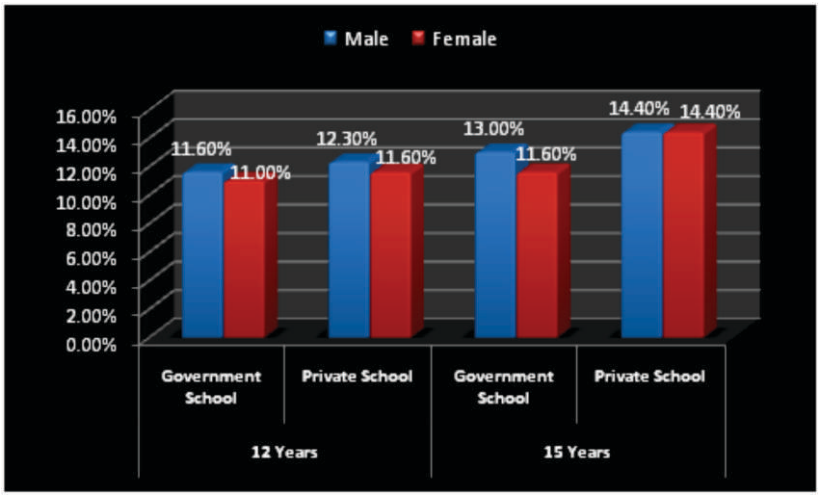


Figure 3: Distribution of School children According to Gender and Age.

Table 1: Mean Caries Experience (DMFT) by Age, Gender, School Type, and Brushing Frequency.

Variable	n	Mean DMFT	SD	p-value
Age				
12 years	340	1.34	1.10	0.032*
15 years	390	1.69	1.25	
Gender				
Male	375	1.71	1.18	0.048*
Female	355	1.38	1.09	
School Type				
Government	345	1.90	1.20	0.001 *
Private	385	1.20	1.10	
Brushing Frequency				
Once daily	425	1.90	1.25	0.005 *
Twice daily	250	1.10	0.90	
Occasionally/Never	55	2.40	1.30	

***Statistically significant**

Table 2: Association between Dental Caries and Snack Consumption between Meals.

Snack Consumption Between Meals	n (%)	Mean DMFT	SD	*f-value*	*p-value*
Never/Rarely	210 (28.8%)	1.10	0.85	10.62	0.001 *
Once daily	280 (38.4%)	1.45	1.05		
More than once daily	240 (32.9%)	2.10	1.30		

***Statistically significant**

DISCUSSION:

The present study aimed to assess and compare the oral health status and treatment needs of 12 and 15-year-old school-going children enrolled in government and private schools in Bhopal city. These two age groups are considered global indicator ages for oral health surveillance by the WHO, as they represent important developmental stages during which

Table 3: Distribution of Treatment Needs among School Children.

Treatment Need	12 year		15 year		Total (n=730)
	Government (n=165)	Private (n=175)	Government (n=180)	Private (n=210)	
Urgent treatment needed	12 (7.3%)	4 (2.3%)	15 (8.3%)	6 (2.9%)	37 (5.1%)
Referral needed	10 (6.1%)	5 (2.9%)	14 (7.8%)	8 (3.8%)	37 (5.1%)
Preventive care	45 (27.3%)	40 (22.9%)	50 (27.8%)	55 (26.2%)	190 (26.0%)
Restorative care	65 (39.4%)	45 (25.7%)	70 (38.9%)	60 (28.6%)	240 (32.9%)
Prosthetic treatment	8 (4.8%)	2 (1.1%)	10 (5.6%)	3 (1.4%)	23 (3.2%)
No treatment needed	25 (15.1%)	79 (45.1%)	21 (11.6%)	78 (37.1%)	203 (27.8%)
Total	165 (100%)	175 (100%)	180 (100%)	210 (100%)	730 (100%)

permanent teeth are fully erupted and preventive interventions can be most impactful. The findings of this study provide valuable insights into the existing disparities in oral health conditions and access to care between children from different school types, which may reflect broader socioeconomic and educational inequalities.

The present study showed a significant association between mean DMFT scores and several demographic and behavioral variables. The increase in caries experience with age, from 1.34 (12-year-olds) to 1.69 (15-year-olds), similar findings from a meta-analysis in India, where mean DMFT values rose from 1.95 at age 12 to 3.31 at age 15.[13] In our study, males (1.71) exhibited higher mean DMFT than females (1.38), a trend also reported in Singh N et al, where 15-year-old males had significantly greater DMFT than females.[14] Boys exhibited a higher mean DMFT score (0.42 ± 0.85) than girls (0.28 ± 0.65), and this difference was statistically significant ($p = 0.041$). This finding is in agreement with studies conducted in Saudi Arabia by Al-Darwish M et al, where male children were reported to have significantly higher caries experience compared to females, likely due to poorer oral hygiene practices and less frequent dental visits among boys.[15] However, a contrasting result was noted in a study from Nepal conducted by Chapain KP et al, where female children had higher mean DMFT scores than their male counterparts, suggesting that sociocultural and behavioral factors can influence gender-related differences in oral health.[16]

A similar trend was observed in the type of school attended, where children studying in government schools demonstrated a significantly higher mean dmft score (0.51 ± 0.90) compared to those in private schools (0.22 ± 0.55), with a p-value of 0.019. This is consistent with findings from a large-scale study involving 28,343 schoolchildren, which reported significantly greater caries prevalence among children attending public schools, likely reflecting disparities in socioeconomic status, dietary habits, and access to dental care.[17] Other regional studies from Turkey and Iran also support this association, attributing the higher dmft scores in government school children to reduced awareness and fewer preventive oral health measures available in public educational settings.[18,19]

In the present study, treatment needs based on WHO criteria showed clear disparities between government and private school children aged 12 and 15. Government school students had a higher need for restorative care (39.4% at age 12 and 38.9% at age 15) compared to their private school counterparts (25.7% and 28.6%). Urgent treatment and referrals were also more common among government schoolchildren, reflecting limited access to timely dental care. Conversely, a higher proportion of private school students required no treatment (45.1% at age 12 and 37.1% at age 15). These findings align with studies from Shimla and Kanpur, where government school students showed significantly greater treatment needs due to socioeconomic disparities and reduced service access.[20,21] This highlights the urgent need for targeted preventive and restorative oral health programs in government schools.

CONCLUSION:

The present study highlights a significant prevalence of dental caries among 12- and 15-year-old

schoolchildren in Bhopal city, with marked differences between government and private school students. Children from government schools exhibited higher mean DMFT scores and greater treatment needs, reflecting the impact of socioeconomic disparities, poor oral hygiene practices, and limited access to dental care. Age, gender, brushing frequency, and dietary habits were significantly associated with caries experience. These findings emphasize the need for early, school-based oral health interventions-particularly in government schools-including preventive education, routine screenings, and accessible restorative services-to reduce oral health inequities and promote lifelong healthy behaviors.

Financial Support and Sponsorship
Nil.

Conflicts of Interest
There are no conflicts of interest.

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Research Article

Patient's Perception after treatment of Mandibular Fracture: A Questionnaire Based Retrospective Study

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ABSTRACT:

Background - Accurate clinical and radiological evaluation of mandibular fracture help in establishing proper diagnosis and restoration of patient's aesthetic, neurological function, and overall oral functions. A proper planned management will improve patient's quality of life. The study includes trauma patients who have been diagnosed with mandibular fracture and their quality of life post operatively.

Materials & Methods - A retrospective study was conducted in our department of those patients who had been diagnosed and managed for mandible fracture in a period of 2023 - 2024. Their reports were examined to identify any post operative complication reported and the patients were interviewed for their postoperative quality of life via questionnaire.

Results - Out of all the panfacial trauma only isolated mandibular fracture were included in the study. A total of 46 cases of isolated mandible fracture who had been operated in our department had been included. 32 males and 14 females with the mean age of 40 years formed the study group. Questionnaire included patient esthetics, malocclusion, speech and sensory deficit. 28 patients reported no complication post operatively where as 4 patients had reported post operative scars, 2 patients had malocclusion whereas 12 patients had sensory deficit.

Conclusion - Among all the post operative complications, sensory deficit was reported most commonly in our study.

KEY WORDS: trauma, Mandible fracture, quality of life, post-operative complication, questionnaire.

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INTRODUCTION:

Due to improvement in road traffic conditions in our country, road traffic accidents and its high velocity impact due to over speeding is a major concern in India. As per the reports from the website of ministry of road transport and Highway a total number of 4,61,312 road traffic accidents (RTAs) have been reported during the calendar year 2022 claiming 1,68,491 deaths and causing injuries to 4,43,366 people.[1] As per the records among the states, the highest number of accidents are recorded in the state of Tamil Nadu 64,105 (13.9%) followed by Madhya Pradesh 54,932 (11.8%).[1] According to the profile of patients, facing injuries due to accidents, young adults, or adults with age group of 18 to 45 are most affected. These young adults may experience emotional, physical, or psychosocial impact on themselves as well as their family. The facial appearance is one of the most vital components of one's personality and body image.

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The World Health Organization (WHO) defines quality of life a subjective evaluation of one's perception of reality relative to one's goals as observed through the lens of culture and value system.[2] In Maxillofacial trauma the most frequently fractured bone is mandible which may lead to various complications such as trismus, restricted mouth opening, disturbed occlusion, airway obstruction and neurosensory deficits.[3]

Quality of life has been rarely reported in the city of Bhopal, Central India hence the present study will provide the Maxillofacial surgeons with better understanding of management of mandible fracture and quality of life of patients.

MATERIALS & METHODS:

A retrospective study was conducted in the department of Maxillofacial Surgery involving 46 patients with mandible fracture. The study period was from August 2023 to August 2024. The aim of the study was to assess the etiology, site and postsurgical complications following open reduction and internal fixation of fracture of mandible. The study had the approval of the institutional ethical committee and the participants were informed about the study. The study group included patients with isolated mandible fracture within the age group (18 to 60 years) who underwent open reduction and internal fixation under local or general anesthesia. The exclusion criteria were pediatric patients and adult patients with pan facial trauma or edentulous arches. Selected patients were given questionnaire and the survey was recorded and analyzed using IBM SPSS Statistics version 30.0**.** A copy of blank questionnaire is attached Figure 1 Descriptive statistics, including frequency and percentage, were used to summarize demographic variables, etiology, fracture site, postoperative complications, and patient-reported outcomes. To assess the association between neurosensory

QUESTIONNAIRE –

Patient's perception of after treatment of mandibular fracture: A questioner based retrospective study.

Date.....

Name.....Age / sex.....

IPD No..... .....

Diagnosis..... .....

Treatment done.....

SPEECH:

1. Do you have speech problem after surgery? (क्या आपको सर्जरी के बाद बोलने में समस्या है ?)
   a) Never (कभी नहीं), b) Sometimes (कभी –कभीं), c) Often (अक्सर)

PARESTHESIA:

1. Do you feel numbness or heaviness after fracture?
   a) Never (कभी नहीं), b) Mild (बहुत कम), c) Always (हमेशा)

OCCLUSION:

1. Do you teeth occlude well? (क्या आपके दॉत अच्छी तरह संपर्क में रहते है?)
   a) Never (कभी नहीं), b) Seldom (हमेशा)

AESTHETIC:

1. Are you displeased or unhappy with the looks of your jaws / facial profile?
   (क्या आप अपने जबड़ें / चेहरे की बनावट से नाखुश हैं?)
   a) Never (कभी नहीं), b) Mild (बहुत कम), c) Good (हमेशा)

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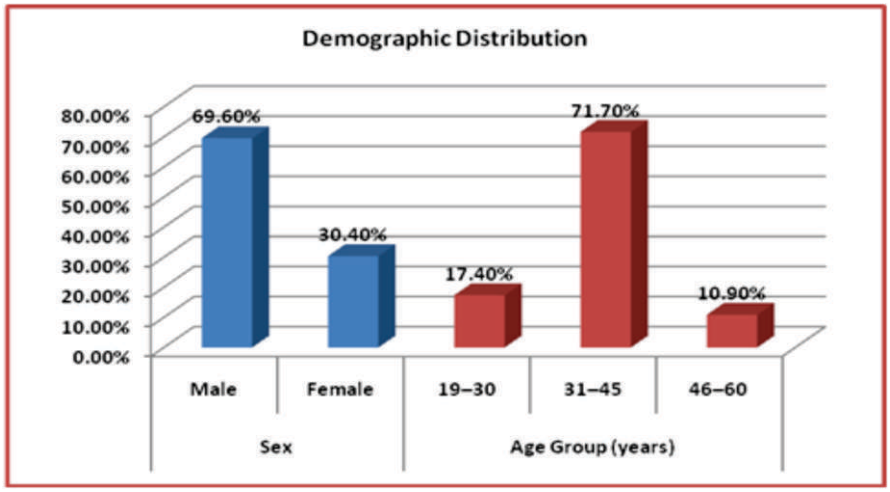

Figure 2: Demographic Characteristics of Patients with Mandible Fractures (n = 46)

Table 1: Distribution of Etiology, Fracture Site, and Postoperative Complications.

Variable	Category	Frequency	Percentage (%)
Etiology	Road Traffic Accident (RTA)	32	69.6%
	Sports Injury	5	10.9%
	Fall	4	8.7%
	Physical Assault	5	10.9%
Fracture Site	Parasymphysis	18	39.1%
	Body	10	21.7%
	Angle	11	23.9%
	Condyle	7	15.2%
Complications	Sensory Disturbance	28	60.9%
	Speech Difficulty	12	26.1%
	Esthetic Disturbance	4	8.7%
	Malocclusion	2	4.3%

Table 2: Distribution of Patient Responses to Post-Surgical Quality of Life and Neurosensory Questions.

Question	Response Category	Frequency (n)	Percentage (%)
1. Do you have speech problems after surgery?	Never	46	100.0%
	Sometimes / Always	0	0.0%
2. Do your teeth occlude well post-surgery?	Mild / Improper occlusion	2	4.3%
	Good occlusion	44	95.7%
3. Are you happy with post-surgery esthetics?	Never	2	4.3%
	Mild / Fine	2	4.3%
	Always / Good	42	91.3%
4. Do you feel numbness post-surgery? (Sensory disturbance)	Never	34	73.9%
	Mild	8	17.4%
	Always	4	8.7%

Table 3: Association between Neurosensory Disturbance and mandibular fracture site.

Neurosensory Disturbance	Total (n=46)	Parasymphysis (n, %)	Body (n, %)	Angle (n, %)	Condylar (n, %)	Chi-Square (?²)	*p*-value
Never	34	10 (29.4%)	9 (26.5%)	8 (23.5%)	7 (20.6%)	6.439	0.375
Mild	8	5 (62.5%)	1 (12.5%)	2 (25.0%)	0 (0.0%)		
Always	4	3 (75.0%)	0 (0.0%)	1 (25.0%)	0 (0.0%)		
Total	46	18 (39.1%)	10 (21.7%)	11 (23.9%)	7 (15.2%)		

disturbance and the site of mandibular fracture**,** the Chi-square (χ^2) test was employed. A *p*-value of <0.05 was considered statistically significant for all tests.

RESULTS:

In the present study comprising of 46 patients with mandibular fractures, a clear male predominance was observed, with 69.6% of the cases occurring in males and 30.4% in females. About age distribution, most fractures were seen in individuals aged 31–45 years, accounting for 71.7% of the cases. Patients in the 19–30 years age group constituted 17.4%, while those aged 46–60 years made up only 10.9%. These findings indicate that mandibular fractures are most commonly seen in middle-aged adults (Figure 2).

In the present study, RTAs emerged as the leading cause of mandibular fractures, accounting for 69.6% of cases. This was followed by sports injuries and physical assaults, each contributing to 10.9% of the cases, while falls were responsible for 8.7% only. These findings highlight the significant role of high-impact trauma, particularly from RTAs, in the etiology of mandibular fractures. Regarding the anatomical site of fractures, the parasymphysis region was most commonly involved (39.1%), followed by the angle (23.9%), body (21.7%), and condylar region (15.2%). This suggests that the anterior and lateral regions of the mandible are more vulnerable to fracture, possibly due to their prominence and structural characteristics. Postoperative complications were reported in a substantial proportion of patients, with sensory disturbances being the most frequent (60.9%). Other complications included speech difficulties (26.1%), esthetic disturbances (8.7%), and malocclusion (4.3%). The high incidence of sensory disturbances underscores the potential for neurosensory impairment following mandibular trauma and surgical interventions (Table 1).

The assessment of patient-reported outcomes following mandibular fracture surgery revealed generally favorable perceptions regarding postoperative quality of life. All patients (100%) reported no speech problems after surgery, indicating effective surgical management in preserving or restoring speech function. Occlusal alignment was also well-maintained, with 95.7% of patients reporting good occlusion, and only 4.3% experiencing mild or improper occlusion. Satisfaction with facial esthetics was high, as 91.3% of patients expressed being always or generally happy with their appearance post-surgery, while only a small proportion (8.6%) reported mild or no satisfaction. However, in terms of neurosensory outcomes, 73.9% of patients reported no numbness, whereas 17.4% experienced mild sensory disturbance and 8.7% reported persistent numbness. These findings highlight that while functional and esthetic outcomes are predominantly positive, a subset of patients continues to experience sensory disturbances, warranting further attention during postoperative care and follow-up (Table 2).

Table 3 shows the association between neurosensory disturbance and fracture site. Although most patients with no disturbance had evenly distributed fracture sites, those with mild or persistent numbness were more commonly associated with parasymphysis fractures. However, the association was not statistically significant (χ^2 = 6.439, *p*= 0.375), indicating that fracture site does not have a significant impact on neurosensory outcomes in this study.

DISCUSSION:

This is a retrospective study which was conducted to assess the etiology, gender and associated complications of patients who underwent open reduction and fixation of isolated mandibular fracture. Maxillofacial trauma with or without facial laceration may lead to morbidity and mortality of the person involved.[4] The Maxillofacial surgeon who manages maxillofacial trauma requires good knowledge of hard and soft tissues, good skill, and adequate experience and if not properly managed, can result in negative psychosocial and functional activity of an injured person.[5]

According to the data published by the Ministry of Road Traffic and Highways in 2022, over-speeding is the major cause (71.2%), followed by driving on the wrong side (5.4%), of the total RTA casualties in India. In our study, road traffic accidents have emerged as the leading cause of trauma, followed by sports injury and physical assault. This has been proved and published in various studies like RK Singh et al.[6] Hu Wcihsin and many others.[6,7] The Ministry of Road and Highway Transport in 2022 published a more male predominance (86.2%), compared to female (13.8%). In the present study, a clear male dominance of 69.6% was observed as compared to 30.4% in females with mandible fracture in RTA. Many other studies reported the same gender distribution, like studies done by Lasse Ostrup Peterson et al and Singh RK.[6,8]

In this study, we selected only those patients who were diagnosed with having isolated mandibular fracture to assess the quality of life (QOL) followed by open reduction and fixation of the fracture site. In QOL, any problems related to speech, occlusion, aesthetic, or neurosensory deficits were recorded. Out of all the post-surgical complications, neurosensory complications were noted more as compared to other complications.

The study conducted by Lilies Dwi Sulistyani also reported neurosensory disturbance as the main complication in the management of mandibular fracture.[9] They reported that most patients experience a peak in neurosensory deficit in the first week post-operation. They also noted that 50 % - 70% of other patients recovered from this deficit over a period of time.

This study has few limitations too as the data was collected only for 1 year, hence sample size was too less which might influence the statistical results of the study.

CONCLUSION:

RTA is the main etiological factor for maxillo-mandibular injury in our country. Proper education of road safety measures should be focused full stop on all post-operative complications. Neurosensory deficit is the most common complication a surgeon encounters, hence a thorough evaluation regarding pre-and post-operative neurosensory evaluation is required for proper management. Sufficient periodic follow-up is advised.

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Conflicts of Interest
There are no conflicts of interest.

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Research Article

Evaluating Dry Chemistry Estimated Direct Low Density Lipoprotein (LDL), Against Calculated LDL from Different Formulae

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ABSTRACT:

Background-Lipid profile is an important investigation for many diseases especially cardiovascular diseases. LDL cholesterol is an important component of lipid profile and direct LDL cholesterol is enzymatic whereas indirect or calculated LDL cholesterol is based on other components of lipid profile and devised by formula. The most well-known is Friedewald's formula. However apart from Freidewald's formula which often doesn't correlate with direct estimation we have many other formulae. This study attempts to correlate Direct LDL cholesterol estimated on Dry chemistry with different formulae.

Materials & Methods-The 202 samples received during study period were correlated with different formulae like Friedewald, Cordova and Cordova, Vujovic et al, Ahmadi et al, Anandaraja et al, Puavilai et al, Hattori et al. and analyzed for the same. The lipid profiles were analyzed on QuidelOrtho's Vitros 4600 Dry chemistry.

Results-Our results showed a negative correlation indicting that Friedewald's formula underestimates LDL cholesterol in comparison to direct estimation. Calculated LDL cholesterol with Friedewald's formula after 400 mg/dL of triglycerides (TGs) was found high undesirable . Our results show that Cordova's formula does not provide any significant advantage over Friedewald's formula and Ahmadi's formula didn't show close correlation.Anandaraja's formula did not provide any advantage over Friedewald's formula for LDL cholesterol estimation.

Conclusion- Direct LDL cholesterol measured using dry chemistry shows good correlation with calculated LDL cholesterol derived from Vujovic's formula in the Indian population and can be reliably used in resource-limited settings across a wide range of TGs concentrations.

KEY WORDS: Direct LDL cholesterol, Friedewald's formula, Dry chemistry, Vujovic's formula, Cardiovascular disease.

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INTRODUCTION:

A lipid profile or lipid panel is a panel of blood tests used to find abnormalities in lipids, such as cholesterol and Triglycerides (TGs) for the diagnosis of cardiovascular disease, certain forms of pancreatitis, and other diseases.[1,2] Of these tests Low- density lipoprotein (LDL) cholesterol is one of the five major groups of lipoprotein directly associated with cardiovascular risk. Therefore, the accurate measurement of LDL cholesterol is crucial. The Lipid profile can be analyzed directly or by calculated way using the Friedewald's formula. This formula requires

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fasting plasma high density lipoprotein cholesterol (HDL), total cholesterol (TC), and TGs, and is calculated as LDL = TC – HDL – (TG/5) for mg/dL(TG/2.2 in mmol/l).[3,4]

But The Friedewald's calculation has also got limitations. If triglyceride levels are 400 mg/dL or higher, LDL cholesterol cannot be calculated, and direct LDL cholesterol assays have to be performed .[5,6] Over years several other formulae were proposed for calculation of LDL. These are Cordova and Cordova et al, Vujovic et al, Ahmadi et al, Anandaraja et al, Puavilai et al, and Hattori et al. [7,8,9,10,11,12] Similar to Friedewald's formula, these formulae also use TGs, TC and HDLto calculate LDL cholesterol but have not been validated in varied populations. In our clinical lab experience we have observed that Direct LDL cholesterol and indirect calculated LDL cholesterol do not often correlate with Friedewald's formula and this often creates confusion among clinicians who know only Friedewald's formula. By considering this ambiguity in reporting, the present study was undertaken with the objectives to calculate LDL cholesterol using various formulae and to compare with direct LDL cholesterol assay, so as to obtain an acceptable formula at our setting in replacement for the direct measurement, hence, making lipid profile estimation cost effective. Usually, all studies comparing direct LDL cholesterol from indirectly calculated LDL cholesterol methods are done on wet chemistry mostly. We evaluated direct LDL Measurementby Dry Chemistry Method Versus calculated LDL Using Various Estimation Formulae.

MATERIALS & METHODS:

The prospective observational study was carried out at a tertiary care, super-speciality of central India, for a duration of 1 week. A total of 202 samples were received during study period and were studied for correlation with different formulae like Friedewald's, Cordova and Cordova, Vujovic et al, Ahmadi et al, Anandaraja et al, Puavilai et al, Hattori et al. and analyzed for the same. The lipid profiles were analyzed on QuidelOrtho's, Vitros 4600 Dry chemistry. Total cholesterol was estimated by Method: Cholesterol Oxidase, Esterase, Peroxidase, HDL by Method: Direct Measure, PTA/Mg Cl2 Enzymatic, LDL by Method: Direct measure, Enzymatic, Triglycerol by Method: Enzymatic – Lipase /Glycerol Kinase. Quality assurance is followed as per norms. LDL cholesterol values were categorized as follows as per ATP III classification[1]Optimal: <100 mg/dL; Near Optimal/Above Optimal: 100-129 mg/dL; Borderline High: 130-159 mg/dL;High: 160-189 mg/dL; Very High: >190 mg/dL. The study was approved by Institutional ethical committee. Statistical analysis was performed by SPSS 20. Mean and standard deviation was calculated for quantitative variable. One way ANOVA test was applied for more than 2 group comparisons and Pearson correlation test was applied for correlation between two variables. If *p*-value was<0.05, it was considered as statistically significant result and if *p*-value was >0.05, then it was statistically insignificant.

RESULTS:

Table 1 depicts the range, mean and SD of various components of lipid profile included in the study. In Table 2 Friedewald's formula showed highest SD (107.1), which means its LDL cholesterol estimates are the most widely scattered and potentially less reliable in heterogeneous population. Cordova, Vujović and Anandaraja formulas all have SDs in the high-20s to low-30s (relative SD ≈ 0.23–0.27), indicating much tighter clustering of estimates around their means. Ahmadi, Puavilai and Hattori, with SDs ~36–50 (relative SD ≈ 0.25–0.31), suggest moderate variability. Table 3 elaborates comparison between LDL cholesterol with different formulae. *p*-value of 0.001 is statistically significant and all the formulae have shown statistical significance results. However, one-way Anova showed a higher F value with of Vujovic et al. A higher F-value indicates that the variability between groups is substantially greater than the variability within groups, suggesting significant differences among the group means. F value was low for Friedewald's formula. Table 4 and Figure 1 showed that Friedewald's formula has negative correlation with direct LDL whereas Vujović et al. (r = 0.706) showed

Table 1: Descriptive statistics of lipid profile variables.

Variable	Minimum	Maximum	Mean	Std. Deviation
TC	96.00	268.00	196.68	33.844
HDL	25.00	110.00	43.16	12.002
LDL	16.00	197.49	111.98	26.740
TG	18.00	476.00	149.63	52.755

Table 2: Descriptive statistics for different formulas calculated.

Variable	Minimum	Maximum	Mean	Std. Deviation
Friedewald's et al. (6) - LDL c=TC-HDLc-TG/5	-199.40	190.20	-73.2072	107.09156
Cordova and Cordova (9) - LDL c=3/4 (TC - HDLc)	18.25	259.50	105.5866	28.41278
Vujovic et al. (11) - LDL c= TC-TG/6. 85 - HDL	49.10	221.20	132.8525	30.20198
Ahmadi et al.(11)- LDL c= TC/1.19 + TG/1.9 - HDLc/1.1	74.31	410.16	205.2765	50.58078
Anandaraja et al. (12)- LDL c= 0.9 TC-0.9/5 -28	16.10	183.14	121.5791	27.73759
Puavilai et al.(13) - LDL c= TC-HDLc - TG/6	-214.00	187.30	127.1892	38.42059
Hattori et al..(16) LDL c=0.94TC-0.94 HDLc -0.19TG	-214.96	170.36	114.8345	36.09543

Table 3: Compare between different categories of Direct LDL with Indirect LDL with different formulae.

Formula	LDL Categories	N	Mean	Std. Deviation	F-test (One way ANOVA test)	*p*-value*
Friedewald's et. al.	Optimal	39	9.48	86.57	14.99	0.0010
	above optimal	135	-103.39	86.86		
	borderline high	14	-62.96	136.17		
	High	14	-22.79	162.13		
Cordova and Cordova	Optimal	39	62.17	18.75	98.302	0.0010
	above optimal	135	113.99	14.31		
	borderline high	14	115.34	13.82		
	High	14	135.71	41.03		
Vujovic et al..	Optimal	39	84.86	19.59	112.053	0.0010
	above optimal	135	142.18	16.86		
	borderline high	14	150.92	17.58		
	High	14	158.55	29.44		
Ahmadi et al..	Optimal	39	144.54	57.07	36.032	0.0010
	above optimal	135	218.89	31.65		
	borderline high	14	214.58	37.83		
	High	14	233.94	65.65		
Anandaraja et al..	Optimal	39	87.03	28.78	42.447	0.0010
	above optimal	135	127.95	18.22		
	borderline high	14	138.27	29.46		
	High	14	139.70	23.02		
Puavilai et al..	Optimal	39	80.32	18.33	39.103	0.0010
	above optimal	135	138.90	17.21		
	borderline high	14	148.02	17.47		
	High	14	123.99	99.96		
Hattori et al..	Optimal	39	75.96	23.73	28.264	0.0010
	above optimal	135	124.40	17.08		
	borderline high	14	136.80	17.15		
	High	14	108.93	95.70		

Table 4: Correlation between direct LDL and different formulas of given patients.

Formula	Direct LDL (Correlation coefficient r)	*p*-value
Friedewald's et al.	-0.340	0.001
Cordova and Cordova	0.639	0.001
Vujovic et al.	0.706	0.001
Ahmadi et al.	0.479	0.001
Anandaraja et al.	0.594	0.001
Panavillai et al.	0.665	0.001
Hattori et al.	0.601	0.001

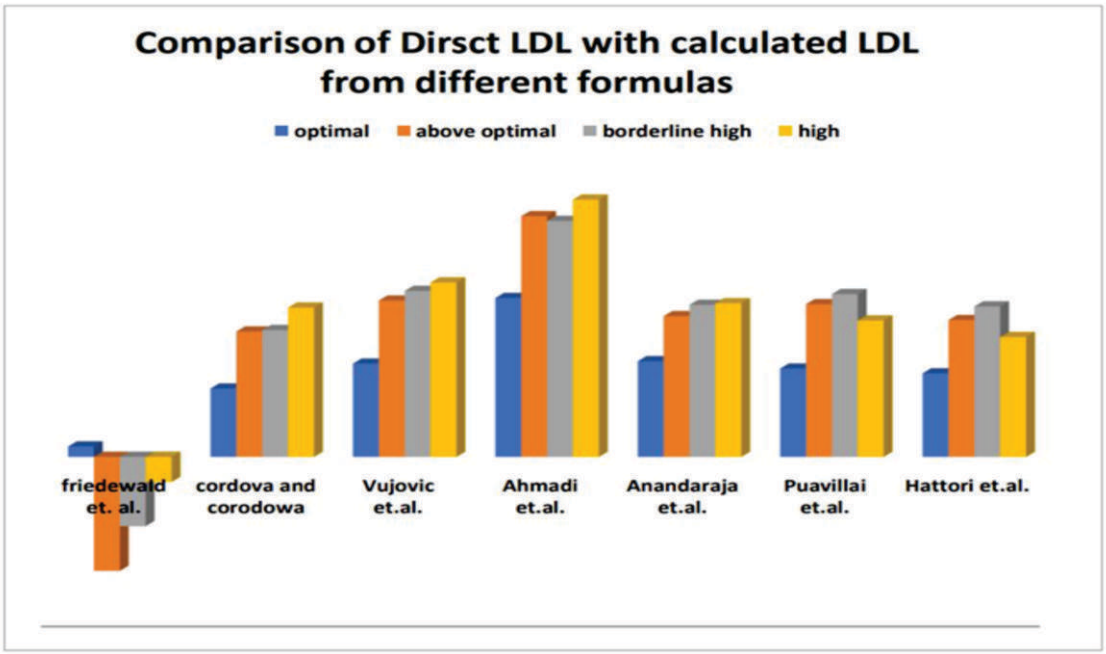

Figure 1: Comparison of Direct LDL cholesterol with Calculated LDL cholesterol from different Formulae.

Table 5: Comparison between values of Direct and indirect LDL cholesterol with TAG levels

Variable	LDL Categories	N	Mean	Std. Deviation	F-test (one way ANOVA test)	*p*-value*
TG	Optimal	39	111.2821	76.83268	11.526	0.001
	above optimal	135	158.3704	34.53070		
	borderline high	14	140.2857	50.85035		
	High	14	181.5714	67.09318		

TG- Triglyceride.

very strong correlation indicating in agreement with direct LDL, followed by Puavilai (r = 0.665) and Cordova (r = 0.639.) Anandaraja (r = 0.594) and Hattori ® = 0.601). Table 5 showed low variance of calculated LDL with respect to TG concentrations with Vujovic et al based calculated LDL.

DISCUSSION:

Increased LDL cholesterol levels is associated with an increase in coronary artery disease (CAD). A 1% greater LDL cholesterol value isassociated with slightly more than a 2% increase in CAD over 6 years.[13]

Most laboratories across the world use Friedewald's formula for LDL cholesterol calculation. However many studies have shown its limitation and some have shown that other equations perform better for certain groups of populations only. Hence in our current study we compared several other formulae being used along with Friedewald's formula with direct LDL cholesterol performed on Vitros Dry Chemistry. Our results showed that negative correlation indicating that Friedewald's formula underestimates LDL cholesterol in comparison to direct estimation. Also, the correlation was better with Vujovic et al.[8]

Our study is in concordance with Wadhwa et al, who had performed a similar study but the platform used was Wet chemistry.[14]

Credibility of calculated LDL cholesterol with Friedewald's formula for values > 400 mg/dL of TG was found highly undesirable. However, Sha MFR et al., in Bangladeshi population concluded that Friedewald's formula can be used up to serum TG concentration of 700mg/dL.[15]

Cordova and Cordova suggested a new formula that performed better than Friedewald's formula in Brazilian population.[7] Our results show that Cordova formula does not provide any significant advantage over Friedewald's formula in Indian population (Table 3, 4; Figure 1). Similarly Ahmadi's formula has been validated in Iranian subjects at TG<300mg/dL.[9] However, our study didn't show strong correlation. Hence, it is not suitable to be used.

Our study is in concordance with the study done by Gupta S et al., which concluded that Anandaraja formula does not provide any advantage over Friedewald's formula for LDL cholesterol estimation in Indian population[16]. This is contradictory to the study done by Anandaraja et al., which found their formula more accurate than Friedewald's formula for TG <350mg/dL[10]. The modified Friedwald's equation developed by Cordova et al, Puavilai et al, and Hattori et al all showed almost similar correlation with direct estimations of LDL[7,11,12]. Our study supports the study done by Vujovic et al, which validated a modifiedformula in Serbian population with TG<400mg/dL[8]. In our study it was correlating with wide range of TG levels as well.

CONCLUSION:

Direct LDL cholesterol from Dry chemistry better correlates with calculated LDL cholesterol from Vujovic formula for Indian population when compared to Friedewald's formula and when needed can be used in resource poor settings over a wide range of triglyceride concentration.

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Nil.

Conflicts of Interest
There are no conflicts of interest.

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